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The mobile satellite company

BGAN Radio Module Technical Specification

Version 1.5

Publication Date: 02-Jul-2018

Contents

1: Version History

Version	Date	Description

1.5	02-Jul-2018	Section 5.5 'Vibration Considerations' - Added a paragraph at the end of the section saying 'Vibration aspects are discussed in more detail in the *BRM Under Aeronautical Vibration Profiles Technical Note*, where the BRM testing undertaken was subject to aeronautical vibration profiles (helicopter). Land and Maritime vibration profiles are more benign'; Section 7.4.1 'Control Interface' - Clarified that PIN #12 USIM_EVENT is used to detect external USIM insertion or removal; Section 9.8 'RESTful Roles' - Added APIs '/config/isatdefaults', '/device/fem/cable_loss' and '/at/{at_id}', and removed '/device/firmware/webui'; Section 9.9 'BRM Configuration Keys' - Clarified that equalisation_flags should be 00000001 for aero terminals and 00000000 for all other UT types, and added '/adminconnection/route', 'device/fem/measure_noise_figure', and '/device/fem/intermod_test_info'; Section 9.9 'BRM Configuration Keys' - Added 'int_ant_cal_ guard_ms'; Section 9.10 'Websockets' - Added a sentence about Fast, medium and slow for configurable frequency of Temperature and Location notifications; Section 14.3.3 'Transmitter Emissions' - Removed the sentence saying 'For Classes 2, 9, 10, 11 and 14 a single SAW filter can be used. For classes 1, 3 and 8 frequency band specific transmit filtering should be used in the FEM, controlled by the BRM GPIO (**External Transmit Filtering Control**) ' and replaced it with 'Refer to *Transmitter Chain Filtering in BRM-Based BGAN Terminals* and *Front End Module Interface Control Document*, which describe an interface for the FEM to provided filter switching for out-of-band noise reduction (**External Transmit Filtering Control**) in the required classes. This can either be done via the FEM I²C interface or by using BRM GPIO' in the second paragraph, and added 'Similarly, additional filtering is required for aeronautical classes, to ensure compliance in the GNSS bands as specified by ETSI and the FCC. For further details, please refer to *Transmitter Chain*

		Filtering in BRM-Based BGAN Terminals' to the end of the third paragraph; Added EN301 473 to list of standards that the BRM must meet, and clarified the UT classes that the BRM is suitable for use with; Section 14.3.3.2 'Transmitter Masks' - updated the first screen shot in that section, clarified in the first paragraph that toughest requirement for spectral re-growth in the HPA relates to Aeronautical classes, amended the Note so it references EN300 473 limit rather than 444 limit and removed reference to 5dB extra margin, and re-named the label for Figure 31; Section 14.3.4 'Receiver Input (RX_IN)' - Clarified the Notes for Noise Figure Low Gain so they now say 'In the presence of an in-band interferer at -45dBm at the reference (non-ATC compliant) FEM input. For an ATC compliant FEM, low gain is not used because protection from large interferers is provided by the FEM'; Section 16 'BRM Terminal Class and Operations' - Added aero terminals, and added ASS and EASS to list of FEM information fed to the BRM; Section 18 'BGAN Type Approval' - Clarified the UT classes that the BRM is suitable for use with, and made various amendments to the BGAN Class table; Section 19.1 'BGAN Received Interference Rejection' - Updated the LTE Band 21 Interferer details, clarified in the Notes that the assumption is being made for a FEM that is non-ATC/LTE compliant and the BRM is in ATC gain mode, and clarified the second paragraph in the Notes section about ATC/LTE-compliant and non-ATC/LTE-compliant FEM; Section 20 'BRM Key Blocks' - Added the following to the third paragraph: 'High rejection custom SAW filters are used to reject LTE band 21 transmissions up to 1517MHz. If the BRM receiver is tuned between 1524-1559MHz, the input filtering is internally switched to provide additional protection. Further interference rejection can be obtained by using a higher performance ATC/LTE Front End Module. Refer to the ATC and LTE Compliant Front End Design for more details'.

2: Conventions-BRM

This document uses the following conventions.

Note: Key points are shown in this format.

Bold font indicates commands, keywords and text labels on GUI items.

Italic font indicates titles of other documents in the suite of BRM-related documentation.

`Monospace font` indicates text that you must enter.

SMALL CAPITALS indicate keys that you must press.

3: Introduction

Note: The content of this document is Inmarsat proprietary and confidential, and as such external distribution is available only to Inmarsat-approved Value Added Manufacturer Partners involved in development using the BGAN Radio Module.

This document describes for Inmarsat's **Value Added Manufacturer** (**VAM**) Partners the technical specifications for the **BGAN Radio Module** (**BRM**) to assist them to integrate the BRM into **Broadband Global Access Network** (**BGAN**) Terminals.

Note: This document contains target values with some data obtained from initial testing, and as such revised and supplementary data will be published at a later date.

4: Environmental Specifications

The environmental specifications for both operating within specification and survival without damage of the BRM are defined in this section.

4.1: BRM Operating Environment Specifications

Table 1 shows the environmental specifications within which the BRM can achieve optimal operation.

Parameter	Specification	Notes
Ambient operating temperature	-40ºC to 75ºC when mounted with a heatsink capable of 2 degrees Celsius per watt thermal dissipation.	External heat sinking must be added to maintain BRM PCB temperature at < 85°C.
Ambient operating temperature	-40ºC to 65ºC	BRM mounted on HDK with no external heat sinking
Relative humidity	up to 95% at 40°C	
Vibration - random	Random vibration of 1.05g rms in each of three mutually perpendicular axes. The spectrum of the vibration is as follows: 5 to 20 Hz 0.02g^2/Hz 20 to 150Hz -3dB/octave	

Table 1. BRM Operating Environment Specifications

4.2: Over Temperature Management

Temperature sensors are located in the BRM and FEM. As the detected temperature in either the BRM or FEM rise to close to the maximum permissible level, the user is warned via the user interfaces allowing the user to moderate the terminal's transmissions and heat generation.

When excessive temperatures are detected in either the BRM or FEM, after warning the user via the user interfaces, the BRM will stop transmissions, close its BGAN network connection and go into low power mode as defined in **System Power Modes**. This will minimise the terminal's power consumption and heat generation whilst still powered.

If the user attempts to put the BRM back into operational mode whilst over temperature the BRM will immediately go back into low power mode. If the user power cycles or resets the BRM whilst it is still too hot, the BRM will revert to low power mode once it has read the temperature sensors.

The user is alerted of high temperatures within the BRM and FEM via the websocket or AT interfaces.

4.2.1: Warning Levels

Table 2 shows the different temperature warning levels for the BRM and FEM.

Level	Reported Status	BRM PCB temperature	FEM Temperature
0	OK	<80 °C	As defined within the FEM or by the terminal manufacturer.
1	Hot	81 - 83 °C	
2	Very Hot	84 - 85 °C	
3	Too Hot	>85 °C	

Table 2. Temperature Warning Levels

4.2.2: Warning Level Descriptions

Level	Reported Status	Meaning	BRM Action	Recommend VAM/User action
0	OK	Normal Operation	Continue normal operation – all components within spec. Report status via the websocket or AT interface.	N/A.
1	Hot	Warning	Continue normal operation– all components within spec. Report status via the websocket or AT interface.	Warning that the BRM/FEM is getting hot. Recommend starting any heat reduction methods Recommend or possibly enforce on user that they stop transmissions to minimise further heat rise.

Level	Reported Status	Meaning	BRM Action	Recommend VAM/User action
2	Very Hot	User recommended to stop transmissions	Continue normal operation – all components within spec. Report status via the websocket or AT interface.	Warning that the BRM/FEM is getting hot. Recommend starting any heat reduction methods Recommend or possibly enforce on user that they stop transmissions to minimise further heat rise.
3	Too Hot	Imminent shutdown	Report status via the websocket or AT interface – go into low power mode according to section 3.2 of the BRM tech spec "Over Temperature Management".	Inform user why BRM not operational.

Table 3. Warning Level Descriptions

4.2.3: Outputs

	<80°C	81 - 83°C	84 - 85°C	>85°C
AT Command	0,0,<80,<80 OK	1,1,81-3,81-3 HOT	2,2,84-5,84-5 VERY HOT	3,3,>85,>85 TOO HOT
API	<80	81 - 83	84 - 85	>85
Websocket	{"statuscode":200,"data":{"brmTemp":[<80],"femTemp":[<80]},"type":"temperature"}	{"data":{"source":"BRM-1,Hot,81-3"},"type":"alarm"}	{"data":{"source":"BRM-2,Very Hot,84-5"},"type":"alarm"}	{"data":{"source":"BRM-3,Too Hot,[>85]"},"type":"alarm"}

Table 4. Outputs

4.3: BRM Survival Environmental Specifications

Table 5 shows the environmental specifications for the BRM being able to maintain operational survival without damage.

Parameter	Specification	Notes
Survival temperature - powered	-40ºC to 80ºC	BRM powered but not operational

Parameter	Specification	Notes
Relative humidity	up to 95% at 40°C	
Vibration - random	Random vibration of 1.7g rms for a period of two hours in each of three mutually perpendicular axes (six hours total). The spectrum of the vibration is as follows: 5 to 20 Hz — $0.05g^2$/Hz 20 to 150Hz — -3dB/octave	

Table 5. BRM Survival Environmental Specifications

Unless otherwise stated, full performance should return to normal after the excessive constraint(s) have been removed.

5: Mechanical Specifications

This section describes the mechanical specification for the BRM.

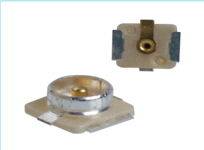
Specification	Details	
Form factor	Credit card sized module with shielding on both sides.	
Pin and hole connectors	Manufacturer: Samtec Mating / un-mating cycles: 100 (As specified by the connector manufacturer) Main: 1 mm pitch 2x25 way socket Part number: CLM-125-02-L-D-A FEM: 1 mm pitch 2x15 way socket Part number: CLM-115-02-L-D-A	
RF connectors 4 pcs, (BGAN_RX, BGAN_TX, RF_DETECT, GNSS_RX)	50Ω U.FL receptacle Manufacturer: Hirose Part number: U.FL-R-SMT-1 Mating / un-mating cycles: 30 (As specified by the connector manufacturer)	
Mechanical fixing	4 x 2.2mm holes suitable for M2 fixings	
Dimensions (nominal)	Length 85 mm Width: 53 mm Thickness: 10.1 mm	
Mass (nominal)	135g	

Table 6. BRM mechanical specifications

5.1: Mechanical Illustration

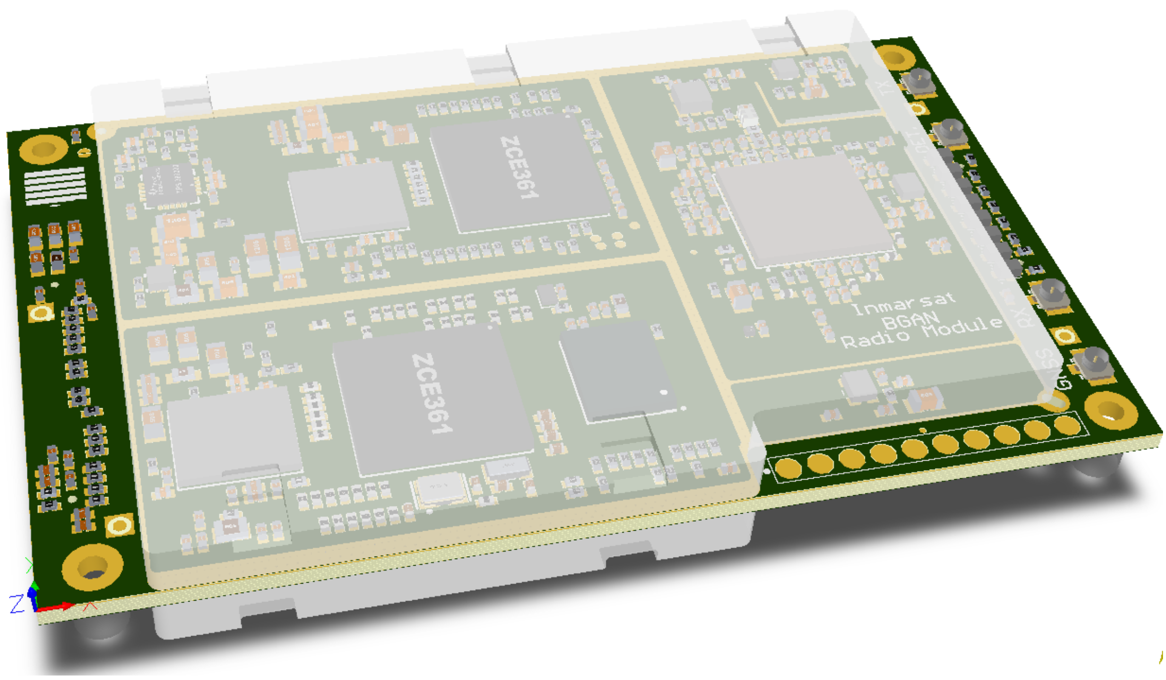


Figure 1. 3D Illustration

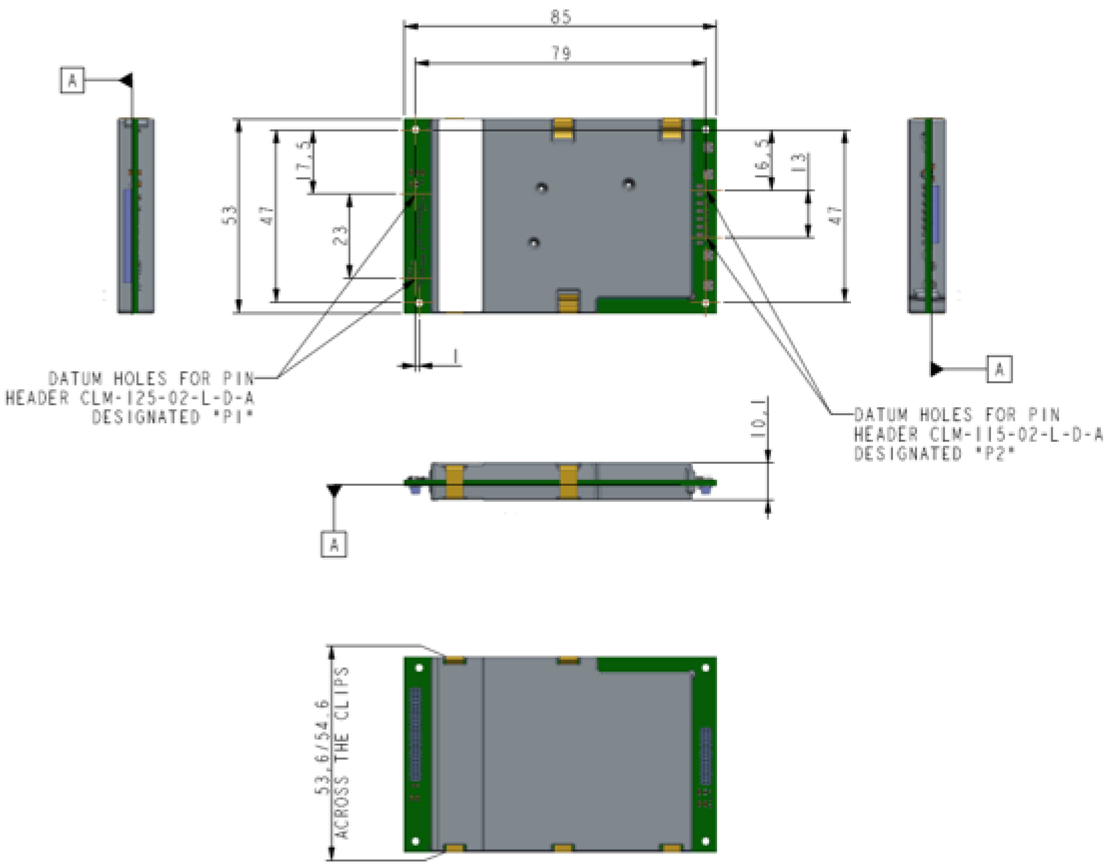


Figure 2. 2D Mechanical Drawing

5.2: Labelling

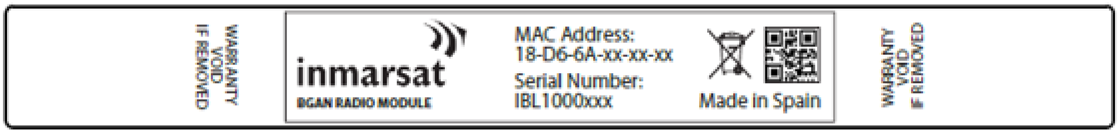


Figure 3. Sample Unit Label

Note: The label in *Figure 3* is an example only.

The BRM label is non-removable and contains:

- The Inmarsat logo and product name (BGAN Radio Module)
- Serial number – 10 characters, e.g., IBL100
- MAC Address
- Applicable certification marks/details
- 5mm X 5mm character QR/Data Matrix code
- The 5mm X 5mm character QR/Data Matrix code contains:
  - Serial Number
  - MAC Address
  - BRM hardware version and modification state – 4 characters (PCB version – 2 characters, modification state – 2 characters), e.g., 0100 = PCB version 01, mod state 03…

5.3: Module Mounting

The BRM mounts to the application PCB through the two dual row 1mm pitch pin and hole connectors with 2mm diameter holes, which are suitable for M2 standoffs and fixings.

5.3.1: Standoffs and Tolerance in Z-Plane

When using the recommended mating connectors, see *Table 7*, the module should be used with 4mm M2 metal standoffs and metal fixings. The shielding may touch the application PCB.

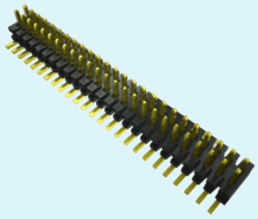
Specification	Details	
Hardware to mount BRM to HDK	4 pcs - 4mm M2 Metal Standoff: Essentra 311220440050 4 pcs - M2 Metal Nut: Duratool M2-HFA2-S100- (Farnell: 1420786) 8 pcs - M2 Metal Washer: Duratool M2 Stainless (Farnell 1377549) 4pcs - M2 Metal Pan Head Machine Screw: Duratool M212 PRSTMCZ100-	
Pin and hole connectors	Manufacturer: Samtec Main: 1 mm pitch 2x25 way terminal strip Part number: FTMH-125-03-F-DV-A FEM: 1 mm pitch 2x15 way terminal strip Part number: FTMH-115-03-F-DV-A	
RF connectors 4 pcs, (BGAN_RX, BGAN_TX, RF_DETECT, GNSS_RX)	50Ω U.FL Manufacturer: Hirose	

Table 7. Recommended connectors and fixings

5.4: Thermal Considerations

Especially when transmitting, the BRM can generate significant amounts of heat that must be dissipated in the terminal for safety and performance reasons.

The amount of thermal dissipation required depends on factors such as the ambient temperature range within the terminal enclosure, the thermal path to the terminal enclosure, the ambient temperature outside the terminal enclosure and the operational duty cycle. For continuous operation at the BRM's maximum rated ambient temperature, a thermal resistance from the top surface of the BRM to ambient of less than 2C/W is required.

Thermal heat dissipation should be enhanced by:

> Thermal heat-sinking between the BRM's top shield can and the enclosure or other heat sink using mechanically compliant heat transfer material

> Maximizing airflow over / around the module

> Improving the thermal conductivity between the BRM and the terminal enclosure

> Locating the module away from other components that generate heat such as the HPA

The BRM's PCB current temperature may be measured using the RESTful command `GET /device/temp` or AT command `_ITEMP`.

For a detailed description of the thermal considerations when designing Terminals using a BRM, refer to *User Terminal Thermal Design Considerations*.

5.5: Vibration Considerations

For operation in environments with high levels of vibration, the following should be considered:

- The use of a mechanically rigid application PCB
- Suitable BRM mechanical fixings
- Suitable RF coaxial cable clamping to minimise the stress on the U.FL RF connectors under vibration conditions

Vibration aspects are discussed in more detail in the *BRM Under Aeronautical Vibration Profiles Technical Note*, where the BRM testing undertaken was subject to aeronautical vibration profiles (helicopter). Land and Maritime vibration profiles are more benign.

6: Power Supplies: BRM

The BRM is required to be powered from two 5.5V (nominal) regulated DC power supplies, one for the digital subsystem and one for the RF subsystem. The power supply requirements for powering the BRM can be found in *Table 8*.

The absolute maximum rating of the supply inputs are -0.3V to 7V.

Parameter		Min	Typ	Max	Units	Notes
VIN_5V5_DIG		5.25	5.5	5.75	V	• Typically VIN_5V5_DIG and VIN_5V5_RF are combined and supplied from a single regulator • There is no specific maximum VIN_5V5_DIG to VIN_5V5_RF voltage difference requirement
VIN_5V5_RF		5.25	5.5	5.75	V	• Typically VIN_5V5_DIG and VIN_5V5_RF are combined and supplied from a single regulator • There is no specific maximum VIN_5V5_DIG to VIN_5V5_RF voltage difference requirement
Power supply ripple	0 to 1KHz	-	-	20	mVpp	For combined VIN_5V5_DIG and VIN_5V5_RF supplies
	>1KHz	-	-	20	mVpp	For combined VIN_5V5_DIG and VIN_5V5_RF supplies
Rated current VIN_5V5_DIG		600	-	-	mA	Continuous full duplex operation. The power supply is required to supply this continuously.
Rated current VIN_5V5_RF		900	-		mA	Continuous full duplex operation. The power supply is required to supply this continuously.
Peak current Sum of VIN_5V5_DIG, VIN_5V5_RF supply currents		-	1600	-	mA	The power supply is required to supply this current very intermittently, for example at initial power up or when starting to transmit. This includes any in-rush current requirement.

Table 8. BRM power supply requirements

6.1: Ground-Plane and De-coupling Recommendations

The BRM has a single ground plane.

Recommendations for the BRM's application PCB include:

- All BRM main and FEM connector ground connections should be directly electrically joined to a continuous ground plane on the application PCB under the BRM
- The BRM's mechanical fixings, consisting of four M2 screws and standoffs, should be directly electrically joined to a continuous ground plane of the application PCB under the BRM
- The BRM's shielding is electrically connected to the BRM's ground plane. For good thermal management of the BRM, this shielding should be thermally connected to the BRM's application PCB. It may also be connected electrically

Note: Power supply over-voltage, reverse voltage, transient or ESD protection is not included in the BRM and is the responsibility of the VAM.

6.2: BRM Power Up Sequence

On applying power, the BRM boots and performs its BIST routines in under 13 seconds. At this point it can respond to local commands. A GPIO pin can be configured as a boot status pin to provide a clear indication that the BRM has booted.

At power up the system tests the following interfaces and device presence:

- $I^2C0/1$
- Ethernet PHY
- mDDR
- NOR flash
- NAND flash
- GNSS
- SIM
- UART0/1
- SPI0/1
- ARM image integrity
- DSP image integrity

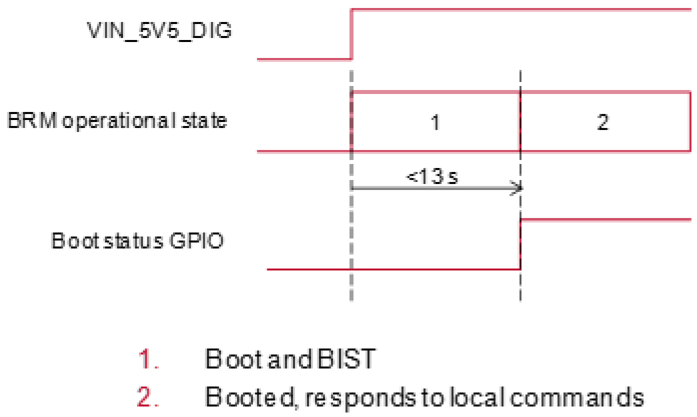


Figure 4. BRM Boot Sequence

Note: VIN_5V5_RF should be powered up simultaneously with VIN_5V5_DIG.

Once the BRM has booted, typically the GNSS receiver will start its acquisition process. Once this is complete the BRM may register and attach to the Inmarsat BGAN network.

6.3: BRM Shutdown Sequence

To shut down the BRM, the BRM's power supplies should be powered-off when the BRM is in low power mode. If the BRM is not in low power mode the following sequence should be followed, per *Figure 5*.

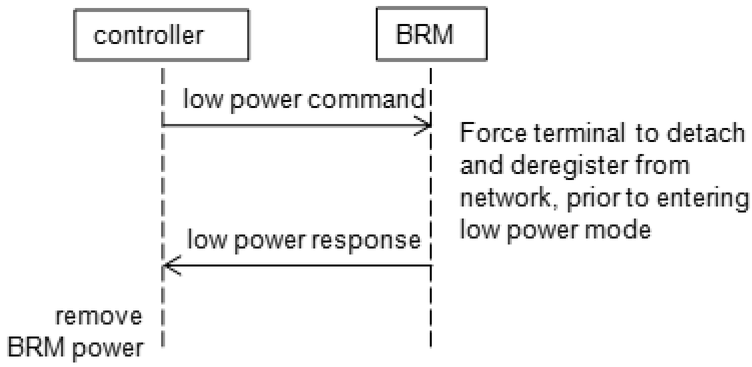


Figure 5. BRM shut-down sequence

Note: VIN_5V5_RF should be powered-off simultaneously with VIN_5V5_DIG.

Once the BRM has booted, typically the GNSS receiver will start its acquisition process. Once this is complete the BRM may register and attach to the satellite network.

6.4: Under-voltage Lockout

The power management section of the BRM includes an under-voltage lockout circuit that monitors the VIN_5V5_DIG supply and shuts the BRM down when the supply falls below the threshold.

Parameter	Min	Typ	Max	Units	Notes
VIN_5V5_DIG rising	4	4.25	4.5	V	

Parameter	Min	Typ	Max	Units	Notes
VIN_5V5_DIG falling	3.5	3.75	4	V	
Hysteresis	-	500	-	mV	

Table 9. Undervoltage lockout levels

The BRM's internal power supplies will power down without warning the user. All interfaces will not function. Once VIN_5V5_DIG returns to the valid range, the BRM will reboot and interfaces will become functional again.

6.5: System Power Modes

The BRM's power modes once booted are:

- **Low Power**:
  - The BRM is powered, in its lowest power mode
  - It is able to respond to local commands
  - The Terminal will be inactive in the network, with the BRM's radio powered down
- **On**: the BRM is configured to connect to, or is already attached to the BGAN network with the BRM's radio operating in either receive or receive and transmit mode
- **Sleep**: the BRM is configured for minimal power draw whilst remaining attached to the BGAN network. The BRM's radio is in discontinuous receive when the terminal is in network idle mode

The BRM's FEM interface allows the FEM to go into a lower power state when the BRM does not need to transmit or receive allowing a low overall power consumption at the terminal level.

The BRM near instantaneously transitions from low power to on and between on and sleep. No specific commands are needed to do this, the BRM's radio will automatically power up when needed. To cleanly transition into low power mode the BRM detaches from the network and waits for the network to confirm that this has happened. The time this takes is network dependent.

The FEM interface is not operational in sleep mode. The BRM may be configured to stay fully on in network idle mode keeping the FEM interface operational.

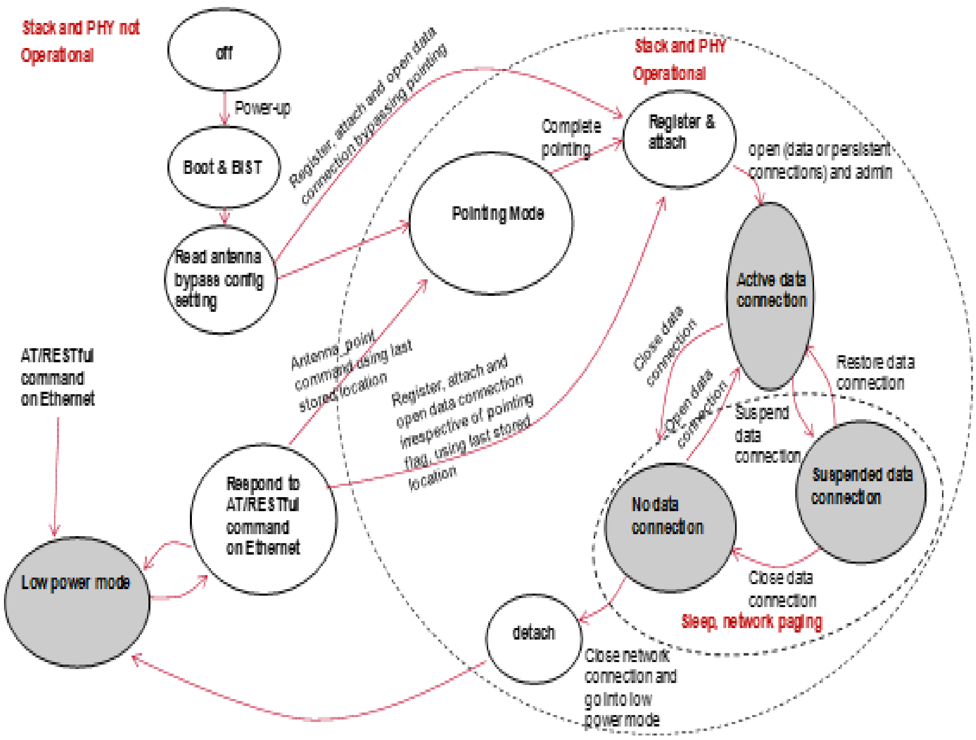


Figure 6. Power Consumption Modes

A configuration option on start-up allows the BRM to either:

> Go into pointing mode allowing the antenna to be pointed, or

> Assuming the antenna is already aligned with the satellite, bypass pointing on boot and attempt to register, attach and open a data connection

6.5.1: BIST

The built-in self-test is generally run in two different situations:

> At power on (PBIST)

> Continuously (CBIST)

The BRM will implement these BIST types as follows:

> The PBIST will check the status of the peripherals/devices at power up. If needed, the devices will be switched on, communication established, test performed before switching them off

> The CBIST monitors the status of the peripherals/devices without (as far as possible) interfering with their normal operation. Note that if a component is disabled or switched off depending on the operational status of the BRM (e.g., low power mode), the CBIST will ignore it

> More detailed tests will be performed using RESTful command (e.g., eprom test can be done by reading/writing to the configuration parameters)

In those situations where a peripheral is used to communicate with a device, a successful test on the device will also imply a healthy state of the peripheral. For example, consider the GNSS receiver that is connected via an I²C-like interface: if the ARM1 is able to read the receiver's software and hardware versions then the I²C peripheral is assumed to work properly.

6.5.1.1: BIST Report

After power on the BIST status can be requested using a RESTful command:

```
/v1/device/bist
```

The response is in the following Javascript Object Notation (JSON) format:


```
[{"module":"phy","status":"unknown"},
{"module":"rfdriver","status":"unknown"},
{"module":"eeprom","status":"ok"},{"module":"gnss","status":"ok"},
{"module":"nor","status":"ok"},{"module":"nand","status":"ok"},
{"module":"dsp1","status":"ok"},{"module":"dsp2","status":"ok"},
{"module":"arm2","status":"ok"}]
```

7: BRM MAIN Interface

This section describes the external interfaces supported by the BRM and provides specific voltage, timing and circuit recommendations for each interface.

7.1: Pin Configuration: Pin Out of the BRM

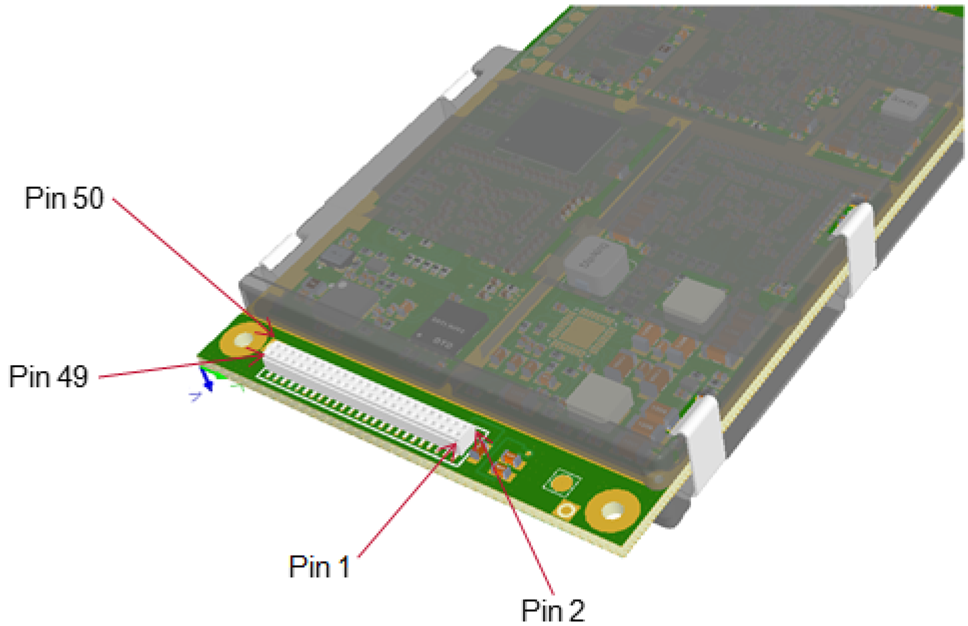


Figure 7. Pin out of the BRM

7.2: Main Connector Pin Description

The following table lists the pin name, direction, function, interface, and required termination if unused of the main connector.

Pin	Name	Group	I/O	Description	Voltage	If unused
1	VIN_5V5_DIG	Power		Digital supply	VIN_5V5_DIG	Must be used
2	VIN_5V5_DIG	Power		Digital supply	VIN_5V5_DIG	Must be used
3	VIN_5V5_DIG	Power		Digital supply	VIN_5V5_DIG	Must be used
4	VIN_5V5_DIG	Power		Digital supply	VIN_5V5_DIG	Must be used
5	GND	Ground		Ground		Ground
6	GND	Ground		Ground		Ground
7	GND	Ground		Ground		Ground
8	Module_nRST	Reset	I	External reset	VIN_5V5_DIG	Open

Pin	Name	Group	I/O	Description	Voltage	If unused
9	GND	Ground		Ground		Ground
10	USIM_EVENT	USIM Control	I	Detects insertion or removal of the USIM	VCC_3V3	Ground
11	GND	Ground		Ground		Ground
12	USIM_SELECT	USIM	I	Selection of internal or external SIM	VCC_3V3	Open
13	GND	Ground		Ground		Ground
14	USIM_DAT	USIM	I/O	Data connection with an external USIM card	VCC_3V3	
15	GND	Ground		Ground		Ground
16	USIM_CLK	USIM	O	Clock connection with an external USIM card	VCC_3V3	
17	GND	Ground		Ground		Ground
18	USIM_RST	USIM	O	Reset connection with an external USIM card	VCC_3V3	
19	GND	Ground		Ground		Ground
20	GND	Ground		Ground		Ground
21	GND	Ground		Ground		Ground
22				Reserved		Open
23	GND	Ground		Ground		Ground
24				Reserved		Open
25	GND	Ground		Ground		Ground
26	GND	Ground		Ground		Ground
27	GND	Ground		Ground		Ground
28	UART1_RXD	UART1	I	UART1 Serial data input	VCC_3V3	Open
29	GND	Ground		Ground		Ground
30	UART1_TXD	UART1	O	UART1 Serial data output	VCC_3V3	Open
31	GND	Ground		Ground		Ground
32	GND	Ground		Ground		Ground
33	GND	Ground		Ground		Ground
34	OMAP1_GP0(9)	GPIO	I/O	General purpose IO	VCC_3V3	Open
35	GND	Ground		Ground		Ground
36	OMAP1_GP0 (10)	GPIO	I/O	General purpose IO	VCC_3V3	Open
37	GND	Ground		Ground		Ground

Pin	Name	Group	I/O	Description	Voltage	If unused
38	OMAP1_GP6 (13)	GPIO	I/O	General purpose IO	VCC_3V3	Open
39	GND	Ground		Ground		Ground
40	OMAP1_GP6 (12)	GPIO	I/O	General purpose IO	VCC_3V3	Open
41	Ether 3V3	Ethernet/SIM		Ethernet LED and SIM supply		Ground
42	GND	Ground		Ground		Ground
43	ETHER_1V8	Ethernet	O	Ethernet transformer centre tap	VCC_3V3	Open
44	ETHERNET_TX_P	Ethernet	O	Ethernet transmit - positive	VCC_3V3	Open
45	GND	Ground		Ground		Ground
46	ETHERNET_TX_N	Ethernet	O	Ethernet transmit - negative	VCC_3V3	Open
47	SPEED_LED2_A_P1	Ethernet	O	Ethernet		Open
48	ETHERNET_RX_P	Ethernet	I	Ethernet receive - positive	VCC_3V3	Open
49	LINK_ACT_LED1_P1	Ethernet	O	Ethernet		Open
50	ETHERNET_RX_N	Ethernet	I	Ethernet receive - negative	VCC_3V3	Open

Table 10. Main connector pin description

7.2.1: Absolute Maximum Ratings

Stress above one or more of the limiting values may cause permanent damage to the device. Exposure to limiting values for extended periods may affect device reliability.

Parameter	Min	Max	Units	Notes
ETHERNET_RX_P, ETHERNET_RX_N, SPEED_LED2_A_P1, ETHERNET_TX_P, LINK_ACT_LED1_P1, ETHERNET_TX_N	-0.5	6	V	With respect to ground
Module_nRST	-0.3	7	V	With respect to ground
USIM_SELECT, UART1_RXD, UART1_TXD, OMAP1_GP0 (9), OMAP1_GP0(10), OMAP1_GP6(13), OMAP1_GP6(12)	-0.3	3.6	V	With respect to ground
ETHER_3V3		3.6	V	With respect to ground

Table 11. Main connector absolute maximum ratings

7.3: Reset

The BRM provides an interface to allow an external application to RESET the module to its power on condition.

The Module_nRST signal is internally pulled-up to VIN_5V5_DIG with a 20kΩ resistor. An open collector transistor or equivalent should be used to ground the signal when necessary to reset the module.

The input should not be pulled or driven high external to the BRM.

Parameter	Symbol	Min	Units	Notes
Logic low input	V_{IL}	0.3 x VIN_5V5_DIG	V	

Table 12. Reset electrical characteristics

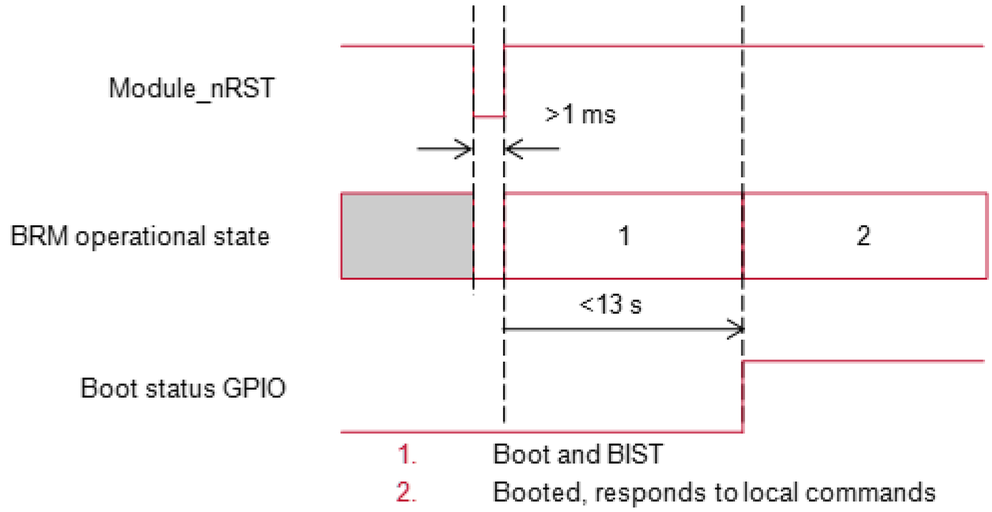


Figure 8. Reset Timing

7.4: USIM

Note: The BRM may include an internal USIM and, if fitted, the details in the following sections can enable its use. At this time Inmarsat requires all VAMs to implement support for **external** USIMs.

7.4.1: Control Interface

The USIM control interface allows the VAM to configure the BRM for either internal or external SIM operation, and to detect SIM insertion or removal.

Pin #	Signal Name	I/O Type	Description	Notes
12	USIM_ SELECT	I	Selection of internal or external SIM	Open = internal SIM, grounded = external SIM

Pin #	Signal Name	I/O Type	Description	Notes
12	USIM_ EVENT	I	Detects insertion or removal of the USIM to trigger a BRM reset	This input detects a rising or falling edge. It is used to detect an external USIM insertion or removal, e.g., if a USIM socket with an integrated switch is used. Use a 100K external pull-up resistor to 3.3V.

Table 13. USIM interface signals

7.4.2: USIM_SELECT Operation

The defined BRM operation with and without an external SIM is shown in *Table 14*.

USIM Select	External SIM	BRM Behaviour
Open	No	Internal SIM
Open	Yes	Indeterminate – not allowed
Low	Not fitted	No valid SIM
Low	Yes - but faulty or not valid	No valid SIM
Low	Yes - working	External SIM

Table 14. Defined BRM Operations - with and without External SIM

Note: In a terminal the USIM_SELECT input must not be accessible to the user.

7.4.3: External SIM Insertion and Removal

The VAM must design the terminal such that it is necessary for the user to initiate a full power cycle or reset of the terminal when inserting or removing the external SIM. This may be done through:

> Fitting the SIM under the battery pack such that power to the BRM is removed when access to the SIM is required

> External to the BRM, detecting a change of state of a SIM detect switch either in the SIM card holder or SIM card slot cover and using this to reset the module, for example using the BRM's `Module_nRST` pin

> Using the BRM's USIM_EVENT input to detect a change of state of a SIM detect switch either in the SIM card holder or SIM card slot cover. On detection of the event the BRM resets itself

7.4.4: USIM Interface

A 'standard' 3V only SIM interface is implemented on the main BRM connector, per *7.4*.

Pin #	Signal Name	I/O Type	Description	Notes
43	ETHER_3V3	O	USIM/Ethernet power supply	3.3V, maximum allowed current draw = 10mA

Pin #	Signal Name	I/O Type	Description	Notes
14	USIM_DAT	I/O	USIM Data	
16	USIM_CLK	O	USIM Clock	Operates at up to 5MHz.
18	USIM_RST	O	USIM Reset Signal	

Table 15. USIM Interface Signals

The PCB trace routing distance between the BRM and USIM holder on the VAMs application board should be as short as possible.

An ESD device specifically designed for SIM cards is recommended for USIM_VCC, USIM_RST, USIM_CLK and USIM_DAT (for example, SEMTECH EClamp2455K, Infineon BGF106C or NXP IP4264CZ8-20-TTL).

7.5: NMEA Data UART

2 wire UART1 is reserved for receiving NMEA data.

Parameter	Symbol	Min	Typ	Max	Units	Notes
Logic low input	V_{IL}			0.8	V	
Logic high input	V_{IH}	2			V	
Logic low output	V_{OL}			0.4	V	$I_{OL} = 4mA$
Logic high output	V_{OH}	2.4			V	$I_{OH} = -4mA$

Table 16. UART1 Electrical characteristics

UART1 is configurable for operation at 4800, 9600, 19200, 38400 baud with the transmission format as shown in *Figure 9*

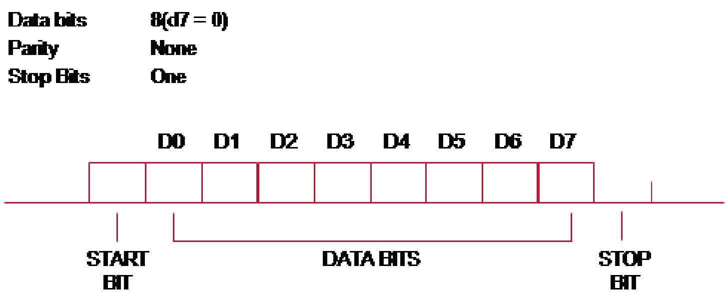


Figure 9. Data Transmission Format

7.6: Ethernet Interface

The BRM has a configurable 10BASE-T or 100Base-TX interface supporting full or half duplex operation with integrated physical layer and support for Ethernet Link activity indicators. An external to the BRM transformer is required.

Parameter	Symbol	Min	Typ	Max	Units	Notes
Transmitter Peak Differential Output Voltage	V_{OUT}	0.95	1	1.05	V	As specified by the Ethernet PHY manufacturer

Table 17. 100Base-TX Transceiver Characteristics

Parameter	Symbol	Min	Typ	Max	Units	Notes
Transmitter Peak Differential Output Voltage	V_{OUT}	1.54	1.75	1.96	V	As specified by the Ethernet PHY manufacturer

Table 18. 10Base-T Transceiver Characteristics

7.6.1: Ethernet Activity Indicator

These are active high indicators typically connected to LEDs.

The LINK_ACT_LED1_P1 output is driven high whenever the Ethernet PHY device detects a valid link, and blinks when CRS is active indicating a valid activity.

The SPEED_LED2_A_P1 is driven active when the operating speed is 100Mbps. This LED will go inactive when the operating speed is 10Mbps or during line isolation.

Parameter	Symbol	Min	Typ	Max	Units	Notes
Low Output Level	V_{OL}			0.4	V	I_{OL}=12mA
High Output Level	V_{OH}	2.75			V	I_{OL}=-12mA

Table 19. Ethernet activity electrical characteristics

Typically when used in a terminal application, each output should be connected in series with a 270Ω resistor and an LED.

7.7: GPIO

The BRM provides up to 4 GPIO for VAM use. They can be configured as:

- BRM activity indicator outputs, for instance to flash LEDs
- Inputs read by a host through the RESTful interface with no interaction with the BRM’s internal systems. An example of the use of these is to provide a button that puts the terminal in and out of antenna pointing mode

> Outputs controlled by a host through the RESTful interface with no interaction with the BRM's internal systems. An example of the use of these is to drive terminal status LEDs

> One of the 4 VAM GPIO's can be configured using /device/gpio as a BRM boot status output through the RESTful interface

> One of the 4 VAM GPIO's can be configured using /device/gpio as a VAM defined default configuration reset input through the RESTful interface

> OMAP1_GP6(13) can be configured using /device/gpio to control external frequency band specific transmit filtering

Parameter	Symbol	Min	Typ	Max	Units	Notes
Logic low input	V_{IL}			0.8	V	
Logic high input	V_{IH}	2			V	
Logic low output	V_{OL}			0.4	V	I_{OL} = 4mA
Logic high output	V_{OH}	2.4			V	I_{OH} = -4mA

Table 20. GPIO electrical characteristics

7.7.1: BRM Activity Indicator

Pin #	Signal Name	I/O Type	Description	Notes
34	OMAP(1)_GP0(9)	I	DSP core active – cycles between high and low.	Intended to flash LED on and off. Under low power and paging cycle conditions the output may appear to freeze.
36	OMAP(1)_GP0(10)	I	BGAN RF receiver input level Output high - signal level overload Output low – Acceptable signal level	
38	OMAP(1)_GP6(13)		External frequency band specific transmit filtering enabled.	

Pin #	Signal Name	I/O Type	Description	Notes
40	OMAP(1)_GP6(12)		Arm core active – cycles between high and low.	Intended to flash LED on and off. Under low power and paging cycle conditions the output may appear to freeze

Figure 10. BRM Activity Indicator

7.7.2: Boot Status Output

Level	Indication
Logic low	BRM booting
Logic high	BRM booted and able to respond to local commands

Table 21. Boot Status Output

7.7.3: VAM Defined Default Configuration Reset Pin

The BRM provides an interface to allow an external application to RESET the module to its VAM defined configuration.

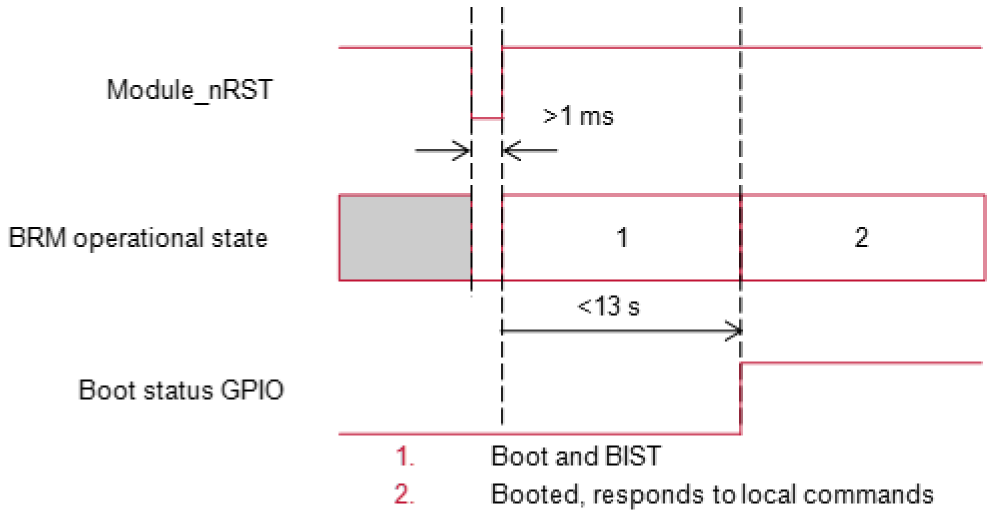


Figure 11. VAM Defined Default Configuration Reset Pin

7.7.4: External Transmit Filtering Control

The BRM provides an interface to control external frequency band specific transmit filtering. This output is driven in:

- Debug mode
- When specifically configured for external transmit filtering enabled using /device/gpio

Level	External Filter
Logic low	Low band (1626.5 to 1650.1 MHz)
Logic high	High band (1650.1 to 1675 MHz)

Figure 12. External filter levels

Note: Refer to **HPA Control** for timing details.

8: BRM External Interfaces

This section provides an overview of the BRM's various secure external interfaces and how they can be used in a range of BGAN IP data and SMS applications.

BRM interfaces available to the VAM are identified in *Figure 13*. Ethernet is used for the BRM's data connection, as well as for local command, monitoring and debug.

What interfaces, and the functionality available to users through these interface is highly configurable, with a permissions scheme used to manage appropriate access to the BRM's resources depending on the terminal application.

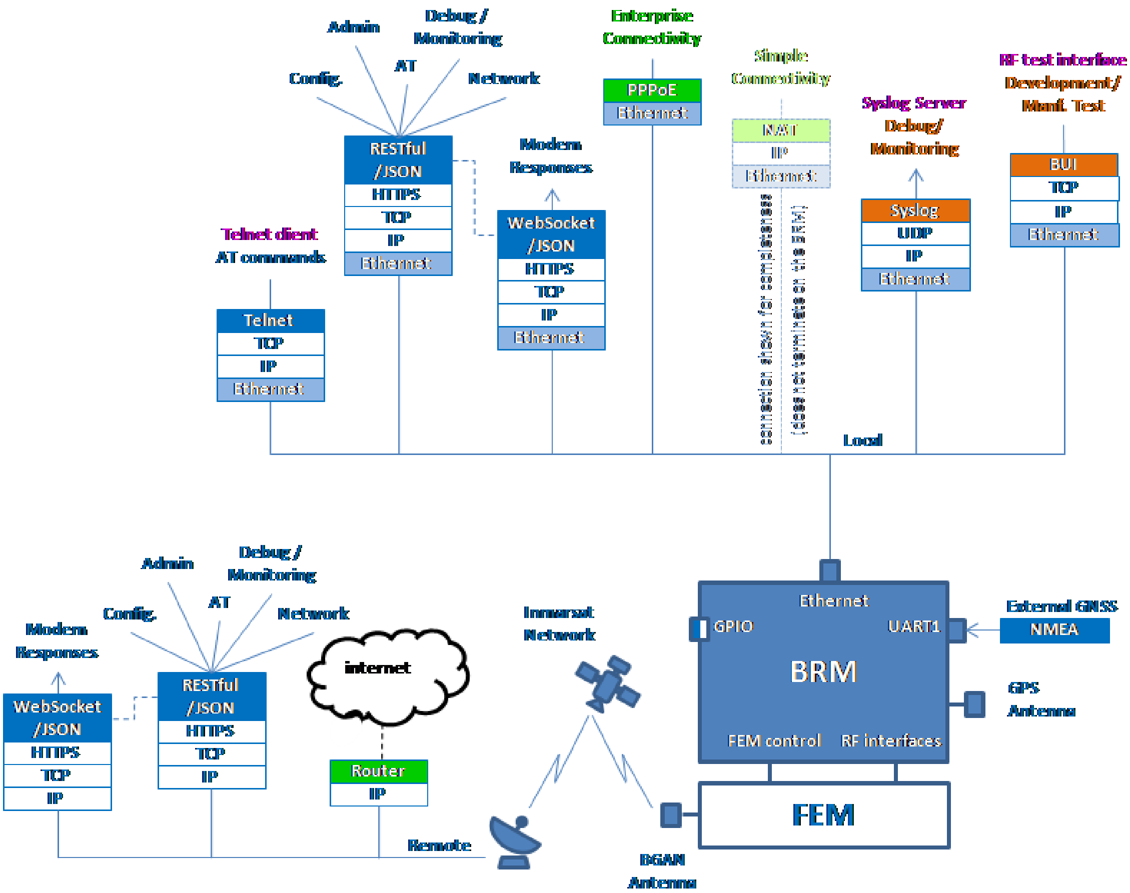


Figure 13. BRM external interfaces

The BRM's RESTful/JSON is the primary human user and machine user interface for management and control including BRM configuration, data connection creation and management, user administration, firmware upgrade and debug/monitoring of the BRM.

To allow continual update of BRM status information and unsolicited responses a Websocket /JSON interface is provided. It is configured through and intended to complement the RESTful interface.

The BRM may also be controlled through an AT over Telnet interface and single AT commands can be encapsulated in a RESTful command. In addition, Point-to-Point Protocol over Ethernet (PPPoE) connections may be created using 'in-band' AT commands.

To allow full remote management and control of the BRM, the RESTful/JSON command and WebSocket /JSON interface can be used remotely through the BGAN network. The BRM uses a separate admin network connection for this, allowing remote management and control of the BRM to be undertaken independently of the user's network data connection. The admin connection is initiated automatically whenever the BRM is attached to the network. It is available for use unless the BRM has a high rate (typically greater than 256Kbit/s) streaming data connection open.

Refer to the *BRM Remote Management Service Description* for further details.

A platform for users to access the admin connection will be provided by Inmarsat.

8.1: Interface Availability

The availability of each interface is typically defined through the BRM's configuration options.

Interface	Transport	Availability	BRM Factory Default
RESTful/JSON	Ethernet Network connection	Always (unless RF test interface in use) When connected to BGAN network	Enabled
Websocket/JSON	Ethernet Network connection	Configurable Configurable when connected to BGAN network	Enabled
AT over Telnet	Ethernet	Configurable	Enabled
PPPoE	Ethernet	Non-configurable	Enabled
Syslog server	Ethernet	Configurable	Not Enabled
RF test interface	Ethernet	Configurable, its use disables other interfaces	Disabled
NMEA	UART1	Configurable, when enabled the internal GNSS is disabled	Disabled

Table 22. Interface Availability

8.2: Web UI

A web based UI is intended as the primary user interface for configuration, for management and control of the BRM.

The Web UI is stored as a ZIP file in the BRM. The pages may be accessed over a secure HTTPS connection and rendered by a browser. The pages include client-side Javascripts to generate the RESTful/JSON commands used to retrieve the BRM information required for populating the web pages. Each page is unzipped by the BRM and served to the client on request.

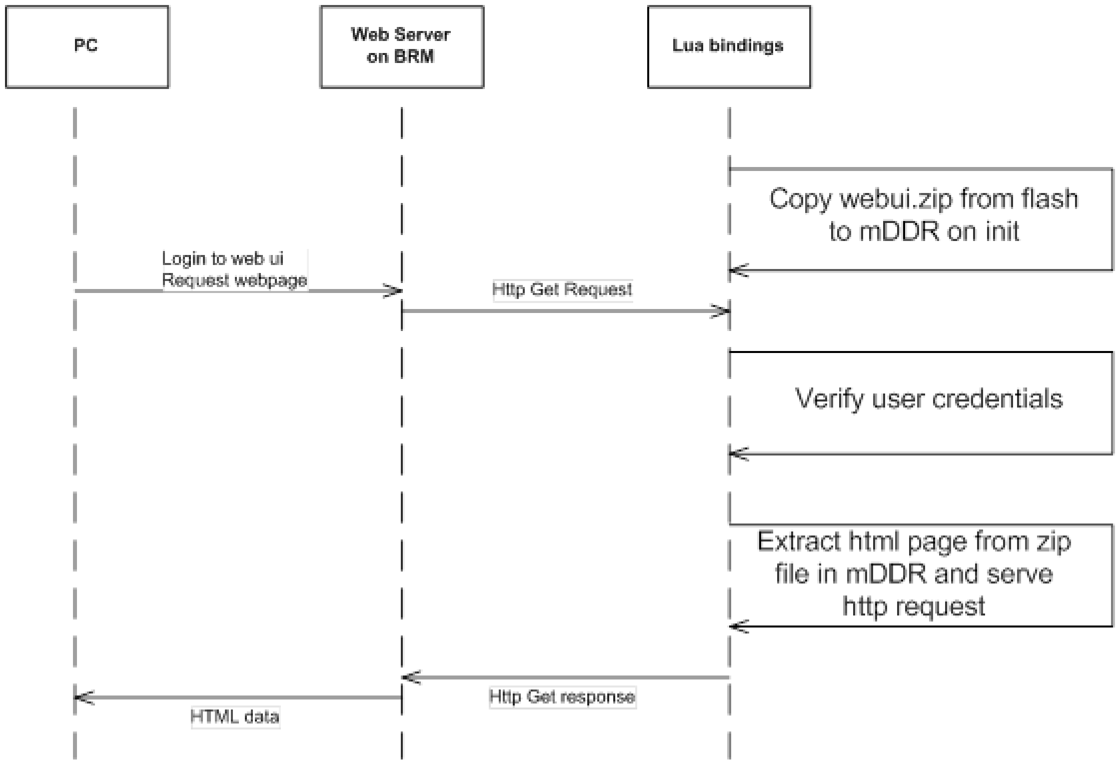


Figure 14. Call flow with correct user name and password

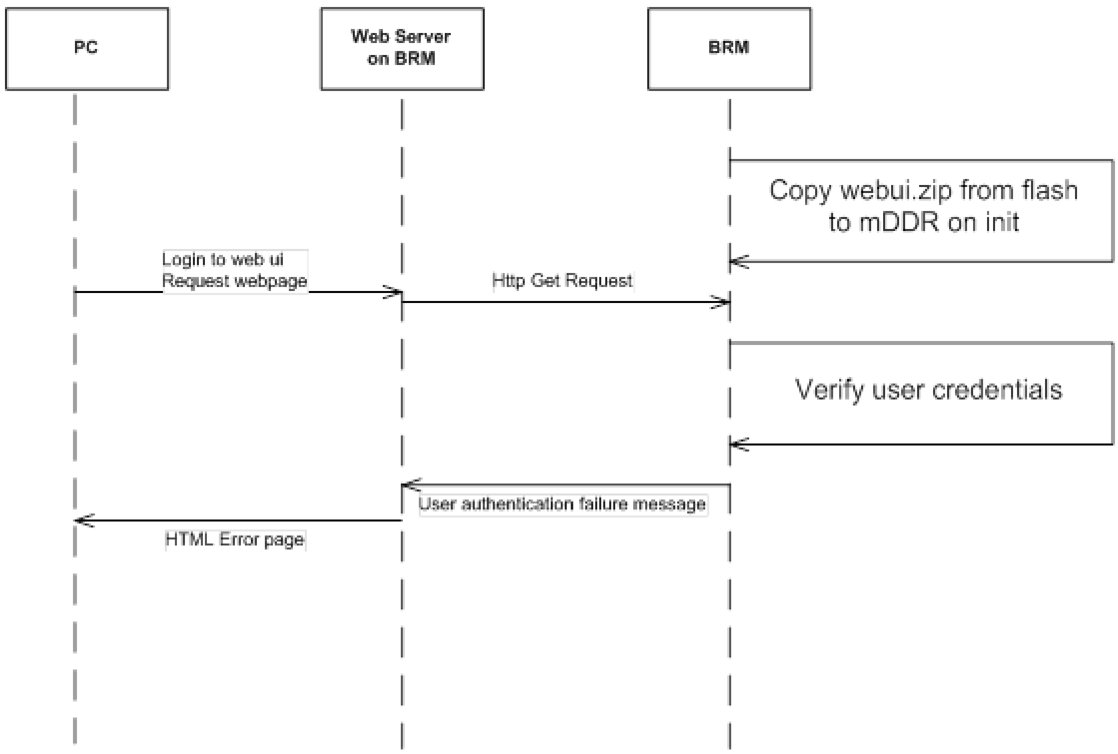


Figure 15. Call flow with incorrect user name and password

The default Web UI supplied with the BRM provides an example of how to manage and control the BRM through the use of RESTful commands and Websockets to control the BRM's resources. It can be accessed from a PC browser by entering `brm.inmarsat.com` as the URL.

The Web UI will be delivered as example code. It is intended to be used as a basis for providing the user a rich web-based terminal front end customised by VAMs to the application and user level with appropriate branding. The ZIP file will be update-able via a RESTful/JSON command, and therefore may be updated locally or remotely over the BGAN network once the terminal is in the field.

VAMs may replace the BRM's default web UI with their own. Installing an empty WebUI zip file disables the WebUI, allowing the user to control the BRM through the RESTful/JSON interface without using a WebUI. A RESTful/JSON command is used to update the Web UI ZIP file allowing the UI to be updated locally or remotely once the terminal is in the field.

To improve the response speed of HTTP requests for resources contained in a web UI zip file uploaded via REST and stored in NAND flash, it is recommended that the number of files is minimised, e.g., by combining HTML, Javascript, CSS or other resources where possible. Response time will increase with the total size of the zip file.

8.3: Ethernet

A 10/100Base-T Ethernet interface, supporting full or half duplex operation, is the primary interface available for:

- Making data connections to the Inmarsat BGAN network
- BRM administration, configuration and monitoring

Note: The BRM's Ethernet interface does not include an Ethernet transformer or RJ45 connector. The transformer and, if required in the terminal implementation, connector shall be added externally to the BRM.

The interface includes auto-negotiation, with the BRM configuring itself to operate at the speed of the slowest device on the network, and activity LEDs.

The interface uses a reduced amplitude mode of 10-BASE-T to lower power consumption of the BRM.

8.4: Networking

The BRM operates, towards the user in either NAT or PPPoE modes. In both modes the BRM's DHCP server is enabled with the BRM using a static IP address. The default address is 192.168.1.1. If the BRM is used with a host with its own DHCP server, the host should be configured to operate with the BRM's fixed IP address. The BRM's static IP address and DHCP IP address range may be configured using the RESTful interface.

The BRM will translate a generic local hostname to the local IP address of the terminal, e.g., `brm.inmarsat.com`.

8.4.1: NAT

In this mode the terminal has one Inmarsat BGAN network connection, and multiple clients share the BGAN data connection through an external to the BRM switch or bridge.

Network Address Translation (NAT) is done automatically by the BRM. Inbound port forwarding/translation is not implemented.

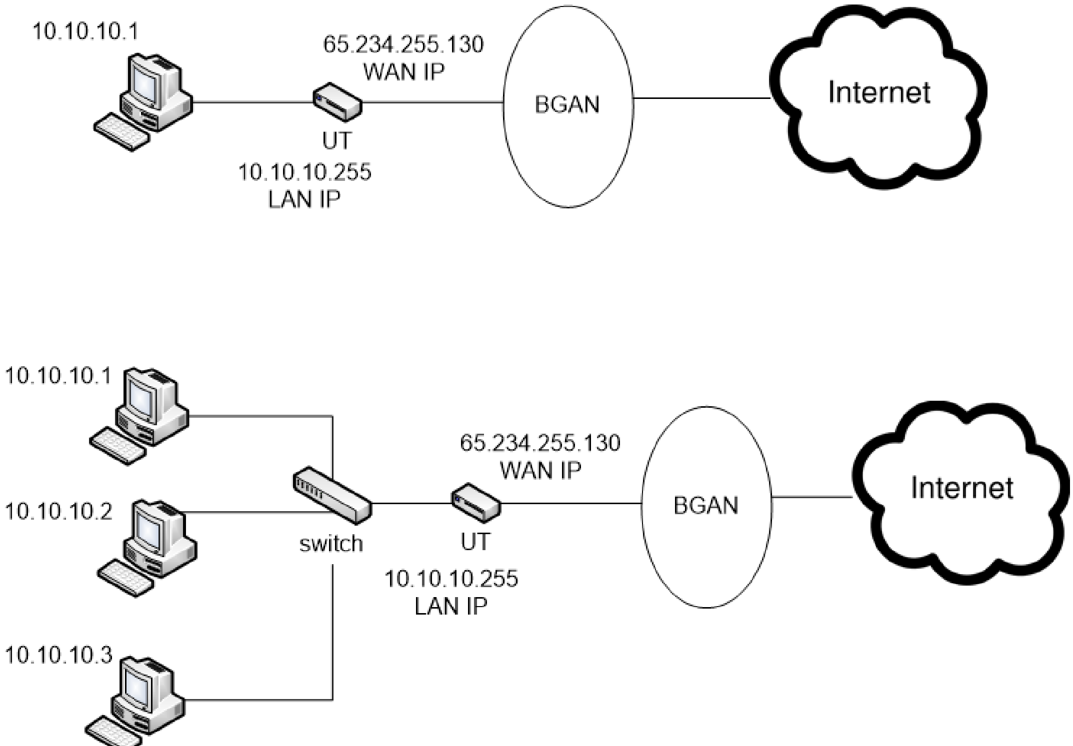


Figure 16. NAT

8.4.2: PPPoE

This mode is active when a connection to the BRM is initiated with a PPPoE client.

There is one satellite network connection associated with each PPPoE session. As the BRM can support up to ten simultaneous satellite network connections, a maximum of 10 simultaneous PPPoE sessions or 9 simultaneous PPPoE session and one NAT session can be supported.

PPPoE sessions can be disconnected and scaled by the RESTful or AT interface.

8.4.3: PPPoE Service Name

Service Name is a tag used in the PADI message, indicating the service the PPPoE client is requesting. The service name is used by the PPPoE client to request a service from the PPPoE server in the BRM should be same as the connection profile name.

The connection profile name determines the QoS, APN, username/password. The username/password is authenticated using CHAP.

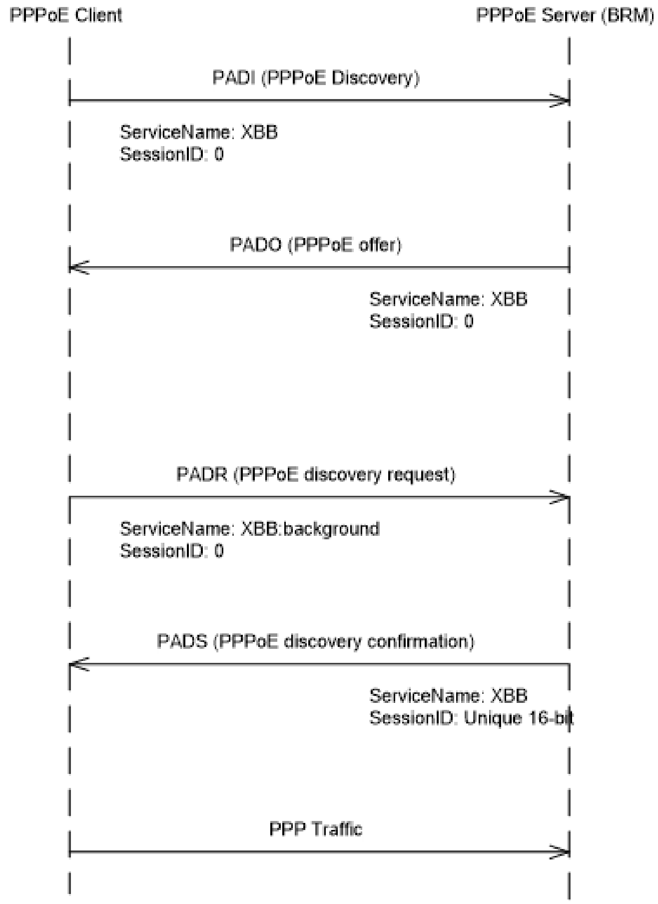


Figure 17. Example - activating a satellite network connection with connection profile name of XBB

8.4.4: Service Descriptor Setting Using RESTful Interface

The Service Descriptor string is called `connectionprofile` in the RESTful context and can be created and modified using the RESTful interface.

8.5: VoIP Streaming

The BRM supports IP based voice transport via PPPoE.

BRM use of the Inmarsat Voice (VoIP) service is through a permanent voice primary PDP context activating as the BRM/terminal registers with the network. The primary context is used for VoIP signalling (SIP registration, dialling/ringing). Upon a call originating from the terminal or terminal inbound the BGAN network will establish a secondary PDP context for the VoIP data traffic.

Please refer to the *BGAN IP Voice Service Description* for further details.

8.6: MAC Address Filtering

The BRM can be configured to only function with a whitelist of up to ten known MAC addresses. If the whitelist is empty all addresses are allowed.

9: Command Interfaces

This section describes the command interfaces that can be used with the BRM.

9.1: RESTful Command Interface

The BRM's RESTful/JSON interface is the primary human user and machine user interface for configuration, network access, i.e., creation of a data connection (PDP context), administration, firmware upgrade and debug/monitoring of the BRM. This HTTPS interface is available locally through the BRM's Ethernet port or remotely via the BGAN connection. The widely adopted REST architecture style, with a lightweight JSON data format allows simple integration and use of the BRM by a broad range of users, developers and integrators connecting from a wide range of devices by utilising a choice of mature and readily available off the shelf software tools and libraries.

To facilitate interface use and minimise integration effort, a Swagger YAML file defining the interface is distributed as part of the SDK.

BRM resources such as activating/deactivating satellite data connections, creating connection profiles, location, BRM firmware upgrade, and BRM configuration are controlled using groups of commands. Access to use and modify these resources is controlled by a user permissions database in which each user's access to appropriate BRM resources is defined.

To deliver notifications of BRM status information, a WebSocket /JSON interface is provided. It is configured through and intended to supplement the RESTful interface. RESTful interfaces are intrinsically stateless with no client context being stored on the server, in this case the BRM. Unless polled for by the client, the BRM would otherwise be unable to send continual status information and unsolicited responses through the RESTful interface.

The RESTful command is in the form of a URL with the following HTTP Methods:

- **POST** – to create a new resource, e.g., create new connection profile is a POST with JSON data on the URL `~/v1/connectionprofile/profile_name`
- **PUT** – to update a particular resource, e.g., update connection profile is a PUT with JSON data on the URL `~/v1/connectionprofile/profile_name`
- **GET** – Read a status or setting, e.g., get device id is a GET on `~/v1/device/id`
- **DELETE** – Delete a resource, e.g., delete connection profile is a DELETE on `~/v1/connectionprofile/profile_name`

Refer to the YAML file for a list of the commands, data formats, and allowed HTTP methods.

9.1.1: User Permissions

Access to use and modify BRM resources through the RESTful interface with associated WebSocket notifications, is controlled by a user permissions database with a permissions table for each user.

Users are identified and authenticated with a username and password.

The BRM may also be configured to allow unauthenticated users to access some BRM resources, such as activating a satellite data connection, messages and obtaining location information allowing basic operation without user name and password. Alternatively the BRM may be configured to require user name and password authentication to access all resources.

9.2: User Authentication

Both local and remote user authentication for the RESTful and websocket interface uses basic HTTP authentication. The username and password are stored with encryption locally on the BRM. User names may be up to 64 printable ASCII characters in length. The BRM supports up to 32 users. If a user loses their password it may be reset by a BRM administrator, i.e., someone with a suitable grant level (see **Permissions Grant Level**). Other interfaces do not require user authentication.

Note: The HTTPS interface supports both TLS 1.1 and 1.2. It is not possible to disable older versions of TLS.

9.3: HTTPS Certificate

A digital certificate is stored in the BRM's non-volatile memory to enable secure connections to be established to it. The default certificate is self-signed with a validity period of 10 years. An updated certificate may be uploaded using the RESTful interface. The updated certificate may also be self-signed, or signed by a Certificate Authority to link to a trusted chain.

The default certificate is self-signed against an Elliptic Curve Cryptography (ECC) private key which is randomly generated for each individual BRM. The BRM's private key, which is unique and different for each BRM for improved security, is also stored in the BRM's non-volatile memory, but cannot be updated.

To generate a new updated certificate for any BRM, the associated private key of the BRM (or Certificate Signing Request [CSR] generated from the private key) must be obtained from Inmarsat's factory database where the private keys were programmed.

Note: Generally, when a web browser first encounters a self-signed certificate, it will prompt the user to choose to accept the certificate and let the browser store it as an exception. However, currently on Apple's OS X, the certificate additionally needs to be installed in order for secure websocket connections to be trusted and established without raising an error. This additional step can be achieved by ticking a checkbox labelled `Always trust "brm.inmarsat.com" when connecting to…` in the prompt provided by Safari. There is currently no known equivalent step for the present version on iOS.

9.4: Permissions Table

Each user is assigned permission values and grant levels across a set of keys. The grant level defines the user's authority to change the permissions record of any user, for each key within their permission table. Keys typically map directly onto a corresponding group of RESTful URLs, and any associated WebSocket notification if applicable.

For example:

- `at` maps onto `/AT`
- `config` maps onto `/config` and `/config/setting/{key}`.

9.5: Permissions Value for RESTful Commands and Websocket Notifications

The permission value {`R`, `W`, `+`, `-`} corresponds to the set of access permissions for the GET, PUT, POST & DELETE methods for the URLs relevant to the key. The permission value controls what a user may do with a BRM. For example, some users may only need to GET (read) the DHCP IP address range whilst other users may want to PUT (modify) the range.

The connection permission value {`R`, `W`, `+`, `-`, `G`} type is an extended type to include a global G flag denoting permission to close any connection, irrespective of whether the user opened the connection.

Table 23 is an example of Permissions Values for an example user named Joe.

Key	Permissions Value	Grant Level
permissions	RW+-	40
connection	RW+-G	40
connectionprofile	RW+-	40
messages	RW+-	40
location	RW+-	40
status	RW+-	40
control	RW+-	40
firmware	RW+-	40
debug	RW+-	40
at	RW+-	40
reboot	RW+-	40

Table 23. Example Permissions Values

9.6: Permissions Value For Configuration Keys

Permissions relating to configuring the BRM are organised in a separate sub-table comprising the list of configuration option keys and four levels {NONE, BASE, RSVD, MANF} of incrementing scopes of access. Users are assigned one of the four access levels to define the scope of configuration options that a user is allowed to access and modify for configuring the BRM. MANF configurations are typically used by VAMs to configure the BRM for correct operation within a terminal. RSVD and BASE are typically used by terminal users to configure their terminal for the current requirements. Users with a NONE permission value cannot modify any aspect of the BRM's configuration.

The configuration access level sub-tables are fixed and cannot be modified through the RESTful API. They are applied to:

- The list read and written using /config
- The list written using /config/defaults
- The access control to individual /config/setting/{key} resources & methods

9.7: Permissions Grant Level

The grant level, a number between 0 and 255, determines the level of authority for a user to change the permission record for any user. The grant level allows users of a BRM to be hierarchically administered. Having a grant level per permission record key allows a finer resolution of administration and may be used to limit the scope of administration of some admin users, e.g. having specific users grant/control permissions only to connection and not any other resource.

A user can change the permission record for any existing user if the user's grant level is higher than the grant level of the target user's record.

A user cannot change the permission record for themselves, except for their own password. This is intended to help avoid accidental lock-out due to a user accidentally disabling their own permissions. If a user wants to access the BRM with reduced permissions, they should create and use a new user with reduced permissions.

In *Figure 18*, connectionadmin can change:

- normaluser's connection & connectionprofile records
- connectionadmin's own password

connectionadmin		
Key	Permissions Value	Grant Level
password	hashed password	40
config	RSVD	40
permissions	RW	40
connection	RW+-G	80
connectionprofile	RW+-	80
messages	RW+-	40
location	R	40
rf		40
gpio		40
firmware		40
debug		40
status	R	40
at		40
reboot		40

normaluser		
Key	Permissions Value	Grant Level
password	hashed password	40
config	BASE	40
permissions		40
connection	R	40
connectionprofile	R	40
messages	RW+-	40
location	R	40
rf		40
gpio		40
firmware		40
debug		40
status	R	40
at		40
reboot		40

Figure 18. Permissions Grant Level Example

If the user is allowed to change an existing permission record:

- The permission value can be set to a value less than or equal to (or a subset of) the value from the user's own permission record – i.e. they cannot give themselves or another user higher access permission.
- The grant level must be set to a value less than the grant level of the user's own permission record – i.e. they cannot give themselves a higher grant level, or another user an equal or higher grant level.

- A user can delete the permission record for any existing user if the user's grant levels are all higher than the grant levels of the target user's records.
- A user cannot delete their own permission table records
- A user can create a new user with permission records according to the same rules as for changing an existing permission record for another user

A superuser has grant level = 255 for all records. They can:

- change any other user records, except for themselves and other superusers
- change their own password

A guest has grant level = 0 for all records. They can only change their own password, and cannot modify any other permission record for themselves or any other user

9.8: RESTful Commands and Command Groups

RESTful commands are grouped into the types identified below. Separate permission keys are applicable for each group. A Swagger YAML file, distributed as part of the SDK fully defines the API.

adminconnection - Admin PDP context control and status

`/adminconnection/status`

`/adminconnection/context`

`/adminconnection/route`

Config - Read and modify BRM configuration options (key, value pairs)

`/config`

`/config/bootset`

`/config/setting/{key}`

Configdefaults - The BRM configuration can be reset to a BRM factory or a VAM defined set of default values

`/config/defaults`

`/config/defaults/save`

`/config/ps_section`

`/config/connectionprofile`

`/config/permissions`

`/config/isatdefaults`

Permissions - Read and Modify user permissions

`/config/permissions`

`/config/permission/{userid}`

Connection - Open, close and modify a satellite data connection

`/connections`

`/connection/{connectionid}`

`/connection/{connectionid}/{secid}`

Connectionprofile

A connection profile defines the necessary network parameters to create a satellite network data connection including the maximum download bit rate, maximum upload bit rate, APN name, etc. Separate data connections may be used for different traffic types.

The connection profile is unique for an active satellite network connection. Once a satellite network connection is created and is activated with a particular connection profile it is not possible to use the same connection profile to activate another satellite network connection.

There is a maximum limit of 64 connection profiles that can be created on the BRM.

`/connectionprofile`

`/connectionprofile/{connectionprofileid}`

Messages - Read and send SMS messages, and get storage status

`/messages`

`/messages/status`

`/message`

`/message/{messageid}`

`/pdumessage`

`/messagesend/text`

`/messagesend/pdu`

`/messagesend/status`

Location - Read location and satellite GNSS data. Location information is not available if the BRM is operating in discrete mode

`/location`

`/location/satellites`

Status - Read BRM and FEM versions, pointing, network, status, usage information, and SIM codes; access, configure and delete logs

`/device/uptime`

`/device/temp`

/device/id

/device/bist

/device/productinfo

/device/customerinfo

/device/usage_statistics

/device/antenna_pointing_info

/device/satellites_table

/device/current_satellite

/device/antenna_pointing

/device/signalstrength

/device/signalstrength_filter

/device/network_attach

/device/usim/status

/device/usim/pinstatus

/device/usim/enterpin

/device/usim/enterpuk

/device/usim/changepin

/device/usim/pinlock

/device/fem/id

/device/fem/userfields

/device/ip_acl/outbound/log

/device/ip_acl/outbound/statistics

/debug/logger/{location}

/debug/logger/{location}/config

/debug/logger/syslog/destination

Control - Read and modify BRM and FEM control points, IP access control list, and send HTTP commands using HTTP proxy

/device/gpio

/device/gpio/{line}

/device/lowpower

/device/ip_acl/outbound

/device/fem/cable_calibration

/device/fem/cable_cal_test_signal

/device/fem/cable_loss

/device/fem/measure_noise_figure

/device/fem/intermod_test_info

/device/fem/tunnel/data

/httpcommand

Notifications - Open WebSocket and configure subscriptions

/notifications/{feed_id}

/notifications/{feed_id}/config

Firmware - Read, control and upload firmware updates; control remote firmware updates; upload WebUI and SSL certificate; change firmware image set and reboot BRM

/device/firmware

/device/firmware/{imageid}

/device/firmware/status

/device/firmware/update_mask

/device/firmware/remote_init

/device/firmware/remote_apply

/device/firmware/ssl_cert

/device/firmware/boot_change

Debug - GNSS configuration and GNSS debug outputs, UART1 test, and Enable BUI mode

/debug/gnss

/debug/gnss/config

/debug/gnss/syscfg

/debug/gnss/coldstart

/debug/uart1test

/debug/enable_bui

AT - Issue AT command

/at

/at/{at_id}

Reboot - Issue reboot request to BRM

```
/reboot
```

9.9: BRM Configuration Keys

BRM configuration keys are listed below with the hardcoded factory default values as specified in *Table 24*.

Configuration Key	Description	Factory Default Value	MANF	RSVD	BASE
gnss_rcv_mode	GNSS receiver mode (internal or external)	internal	RW	-	-
gnss_baud_rate	baud rate for external receiver mode (4800, 9600,19200, 38400)	9600	RW	-	-
telnet_timeout	Telnet idle timeout in seconds	300	RW	-	-
bui_mode	Turn on/off BUI mode for Physical Layer MTR testing	false	RW	-	-
bypass_pointing	Setting to bypass pointing mode on boot (true/false)	false	RW	RW	RW
telnet_enabled	Enable/disable telnet interface (true/false)	false	RW	-	-
mac_address	MAC address of the BRM Ethernet port	MAC address string	R	R	R
serial_number	BRM Serial Number	BRM Serial Number	R	R	R
hardware_version	BRM Hardware Version Number	BRM Hardware Version Number	R	R	R
local_ip	BRM local IP address	192.168.1.1	RW	RW	RW
disable_dhcp_server	Disables the DHCP server	false	RW	RW	-
dhcp_ip_range	DHCP IP address start/end range (format start-end)	11-100	RW	RW	RW
dns_ip	DNS IP address	8.8.8.8	RW	RW	RW
subnet_mask	Subnet mask	255.255.255.0	RW	RW	RW
ctx_down	Flag for automatically tearing down admin PDP context for HDR/X-stream (true or false)	true	R	-	-

Configuration Key	Description	Factory Default Value	MANF	RSVD	BASE
bitrate_limit	Bit rate limit above which admin context is closed, depending on pdp_teardown flag (in kbps)	256	RW	-	-
ciphering_capability_enable	Enable/disable ciphering for engineering use (true or false)	true	RW	RW	-
calibration_flags	Sets the BRM to operate in Closed Loop Mode with the FEM	00000001 **Note:** This setting must be retained as 00000001 to enable the closed loop power control operation of the BRM with the FEM.	RW		
leds_debug	Toggle between debug LEDs and user configured GPIO lines	true	RW	-	-
disable_sleep	Prevent BRM from going into sleep mode	false	RW	-	-
mac_addr_filter_enable	Enables MAC address filtering	false	RW	RW	-
mac_addr_filters	Whitelist for client MAC address filtering	00-00-00-00-00-00;00-00-00-00-00-00;00-00-00-00-00-00;00-00-00-00-00-00;00-00-00-00-00-00;00-00-00-00-00-00;00-00-00-00-00-00;00-00-00-00-00-00;00-00-00-00-00-00;00-00-00-00-00-00	RW	RW	RW
disable_remote_fw	Disable remote firmware upgrades	false	RW	-	-
admin_apn	Admin APN	inm-rm.bgan.inmarsat.com	RW	-	-
gps_beidou	Use of GNSS or beidou	false	RW	-	-
admin_configured	Flag to enable/disable admin connection	false	RW	-	-

Configuration Key	Description	Factory Default Value	MANF	RSVD	BASE
admin_user	Username for Admin APN	<empty>	RW	-	-
admin_password	Password for Admin APN	<empty>	RW	-	-
proxy_forward_ enable	Enable TCP Proxy	false	RW	-	-
proxy_forward_ip	IP address for TCP Proxy	192.168.1.10	RW	-	-
proxy_forward_port	Port number for TCP Proxy	80	RW	-	-
telnet_port	Telnet port for BRM AT handler.	23	RW	-	-
disable_lowpower	Temporarily disables BRM going into low power mode. It resets at the next reboot.	false	RW	RW	-
iphc_rfc2507	Enables RFC2507 header compression.	true	RW	-	-
rohc_rfc3095	Enables RFC3095 header compression.	false	RW	-	-
nispca_enable	Enables network-initiated secondary PDP contexts.	true	RW	-	-
dns_spoof_name	ASCII hostname that the BRM resolves to its IP address for DNS lookup requests	brm.inmarsat.com	RW		
logview_debug_on	Enables connection to the Logview debugger.	true	RW		
equalisation_flags	Controls aeronautical equaliser (should be set to 00000001 for aeronautical terminals, and 00000000 for all other terminals)	00000000	RW		

Configuration Key	Description	Factory Default Value	MANF	RSVD	BASE
fem_fitted	Flag to specify whether the BRM is operating with the FEM.	true	RW		
dhcp_relay_enabled	Enables the DHCP Relay.	false	RW		
dhcp_relay_server_ip	IP address for the DHCP Relay server.	192.168.50.245	RW		
dhcp_relay_ctx_apn	APN for the DHCP Relay PDP context.	inm-dhcprelay.bgan.inmarsat.com	RW		
dhcp_relay_ctx_user	User name for the DHCP Relay PDP context.	<empty>	RW		
dhcp_relay_ctx_password	Password for the DHCP Relay PDP context.	<empty>	RW		
signal_quality_scoring	Linear/logarithmic scaling, smoothing time constant; good level (required, range) hundredths C/No for bearers (T025Q1B, T1Q1B, T1Q4B, T1X4B, T25X4_5B, T25X16_5B, T25X32_6B, T25X64_7B, T45X_8B, T5X4_9B, T5X16_9B, T5X32_11B, T5X64_13B).	log,2;4450,600; 4750,500; 5100,500;5100,600; 5550,200;5750,700; 6200,300;6300,300; 5700,700;5550,600; 5800,700;6400,200; 6450,200	RW		
int_ant_cal_guard_ms	Antenna calibration mode exits after guard time expires	0	RW		

Table 24. BRM Configuration Keys and Factory Defaults

9.10: Websockets

To allow continuous update of BRM status information and notification from the BRM and network without the need for continual polling through the RESTful interface, a WebSocket /JSON interface is provided.

Periodic status updates include:

- Temperature
- Location

> **Note:** The frequency with which these two notifications are updated are manually configurable. Fast, slow, and medium corresponds to every second, every 30 seconds, and every 10 seconds respectively.

Asynchronous notifications include:

- Unsolicited and delayed AT unsolicited responses
- SMS message received
- Signal strength
- Connection status
- Alarm
- Secondary Connection state updates - type = "secondaryconnection"
- Network state updates - type = "network"
- REST command notifications - type = "restcmd"
- Asynchronous SMS send - type = "messagesend"

The messages that get emitted over the websocket are JSON serialised objects constructed as:
{type: <type of message>, data: <message object>}

The <type of message> is a string denoting the type of notification i.e. either "temperature", "location", "at", "message", "signalstrength", "connection", "alarm", "secondaryconnection", "network", or "restcmd", or "messagesend".

For periodic update message types, the <message object> schema is the same as the schema for the response to the corresponding RESTful GET command.

For the asynchronous notifications, the current <message object> schema:

- at: {command: <string>, request_id: <integer>, response: <string>}
- message: {messageid: <integer>, timestamp: <string>, sender: <string>, unreadFlag: <boolean>, dataCodingScheme: <integer>, userDataHeaderFlag: <boolean>, data: <string>, text: <string>}
- signalstrength: {signalstrength: <string>, bearer: <string>, signalquality: <string>}

- connection: `{connectionid: <string>, owner: <string>, status: <string>{"activate:success", "activate:fail", "update:success", "update:fail", "deactivate:success", "deactivate:fail", "active:termination"}, interface: <string>{"nat", "ppp"}, report: <string>}`
- alarm: `{source: <string>}`
- secondaryconnection: `{connectionid: <string>, secid: <string>, owner: <string>, status: <string>{"activate:success", "activate:fail", "update:success", "update:fail", "deactivate:success", "deactivate:fail", "active:termination"}, report: <string>}`
- network: `{msg: <string>}`
- restcmd: `{username: <string>, path: <string>, method: <string>}`
- messagesend: {request_id: <integer>, status: <string>{"sending", "success", "error"}, report: <string>}

9.11: Software Upgrade of the BRM

There are 4 versioned software images (arm1; dsp1; arm2; dsp2) each up to 6MB which make up a working image set for the BRM. For remote software upgrade, to minimise the time and data to be transferred over the BGAN network, the BRM will check which of the four new images it needs to download, as some of the latest images may already be installed.

Software updates can be performed by uploading a set of files saved on the local LAN that the BRM is connected to via Ethernet, or remotely via the BGAN network. Both approaches use the RESTful interface. If the remote download (via the BGAN network) is interrupted, the BRM will pause the download and resume once the BGAN network connection is restored. Once the images have been downloaded to the BRM, the BRM checks the integrity of the images prior to allowing their installation. Remote download time depends on the image size and connection speed. It is typically under 15 minutes per software image.

A local firmware update can be installed immediately via the WebUI. The remote software upgrade is a 2 stage process where the new images are downloaded first and, once a working image set is available on the BRM, the user can then elect to install now, install later or reject installing the available update.

The BRM needs to reboot in order for the new software images to run.

There are two copies of the application image set stored in NOR flash, a current working set and a previous working set (if applicable). If the software update process does not complete successfully, after 3 attempts to boot, then the previous working set is automatically restored. The previous working set can also be restored manually using the RESTful interface.

The current configuration settings are not changed during a firmware upgrade. However any new additional Inmarsat configuration setting that is incompatible with the current settings will reset all settings back to Inmarsat default configuration settings.

9.12: AT over Telnet Command Interface

The BRM may be controlled through an AT over Telnet interface. A Telnet server will be configured on the BRM to listen as default on port 23, the default port for the Telnet protocol. The BRM can be configured to use other ports.

There is no access control on this interface. However a VAM may choose to configure the BRM to completely disable access to the Telnet interface.

Supported AT commands are defined in the *AT Interface Control Document*.

Single AT commands can also be encapsulated in a RESTful command. All AT commands are supported with the exception that 'ITU-T V.25ter' commands relating to command line and response formatting are not supported. This allows over air control of the BRM with AT commands.

9.13: Cloning BRM Overall Configuration

The overall BRM configuration information comprises:

- VAM configuration settings
- WebUI
- User permissions

VAMs can programme multiple BRMs with the same overall BRM configuration using simple scripts, containing multiple RESTful commands, to write the VAM configuration settings, WebUI and user permissions to each BRM.

In addition, VAMs can use scripts, containing multiple RESTful commands, to read a BRMs overall configuration (VAM configuration settings, WebUI and user permissions) and write this to another BRM (or BRMs).

10: NMEA Interface Specification

BGAN uses the terminal location for purposes such as aiding initial acquisition of the satellite signal and spot beam selection. This location data is also made available for use within applications using the BRM.

2D velocity information may be used by the FEM to provide a differential compass for aiding the alignment of automatically steered antennas with the satellite.

By default the BRM's onboard GNSS is enabled. As an alternative to the onboard GNSS receiver, the BRM may be configured to use an external GNSS receiver or other navigation system able to provide NMEA 0183 sentences to the BRM’s NMEA data UART interface as defined in **NMEA Data UART** with either $GN and $GP talker IDs.

If the NMEA interface is used, the required NMEA sentences for land and maritime operation are:

- GGA – Time, position and fix related data for a GPS receiver
- RMC. - Recommended Minimum Specific GNSS Data
- GSA – GPS DOP and active satellites – for getting 2D/3D fix types

Other NMEA sentences not required by the BRM are discarded.

When the BRM is configured to use an external GNSS receiver or other navigation system, the internal GNSS receiver is disabled.

11: Development and Monitoring Interfaces

A range of interfaces are provided for development, debug and monitoring of terminals containing the BRM. These include:

- RF test interface. This provides a standard interface for terminal level BGAN physical layer approval testing using the BGAN Physical Layer Tester (BPLT)

  Note: Refer to **RF Test Interface** for more details.

- Monitoring (Logging and Syslog) - Refer to the **Logging** and **Syslog Specification** sections

11.1: Logging

Two logging interfaces are provided for development, debug and monitoring of terminals containing the BRM. These are:

- Syslog with a client embedded in the BRM allowing run time traces to be collected and displayed locally to the BRM.
- Logging with traces written to the BRM's volatile or non-volatile memory. Configuring the data to be collected, and the retrieval of the log file (a text file) through the RESTful interface using an HTTP get.

Logging through the RESTful interface is intended primarily as a remote debug/monitoring interface while Syslog is only available locally.

Both Syslog and logging via the RESTful interface share the same infrastructure with independent filters available to control the amount of data collected. Up to 4MB of either NAND or RAM memory, configured through the RESTful interface, is available for logging with circular overwriting of the oldest data. The NAND memory has a log erase/write cycle endurance of 100k cycles and data retention of ten years. By default only errors are saved.

Logging information that can be collected include system errors, warnings and informational messages, including:

- The current state of key protocol stack state machines
- The current status of the GNSS receiver
- Progress updates for processes such as firmware updates

Logs can be deleted via the RESTful interface by a user with the appropriate level of permissions.

11.2: Syslog Specification

The Syslog message system provides extensive run time information through a widely adopted standard (RFC5424). A Syslog originator runs on the BRM. When enabled and configured it outputs traces over UDP/IP. A Syslog collector or server must be present on the local network to collect and show the traces.

11.2.1: Syslog Message Format

A Syslog message consists of three parts

`<PRI> HEADER MSG`

Where <PRI> is the priority

`HEADER` is the message header

`MSG` is the message content

The total length of the packet cannot exceed 1024 bytes. There is no minimum length.

11.2.2: Priority

The PRI is an 8 bit number enclosed in angle brackets; it represents the Facility and Severity of the message. The first 3 bits represent the severity of the message and the last 5 bits represent the Facility of the message.

FACILITY (5 bits)	SEVERITY (3 bits)

Figure 19. Data Format

11.2.2.1: Facility

The syslog standard specifies 24 facility levels, all the syslog messages from the BRM will use facility code 1 (user-level messages).

11.2.2.2: Severity Levels

The following severity levels are used based on those defined in RFC 5424.

Code	Severity	Keyword	Description	General Description
0	Emergency	emerg (panic)	System is unusable.	Not used
1	Alert	Alert	Action must be taken immediately.	Not used
2	Critical	Crit	Critical conditions.	Not used
3	Error	err (error)	Error conditions.	Non-urgent failures, these should be relayed to developers or admins; each item must be resolved within a given time.
4	Warning	warning (warn)	Warning conditions.	Warning messages, not an error, but indication that an error will occur if action is not taken, e.g. file system 85% full - each item must be resolved within a given time.
5	Notice	Notice	Normal but significant condition.	Not used

Code	Severity	Keyword	Description	General Description
6	Informational	Info	Informational messages.	Normal operational messages - may be harvested for reporting, measuring throughput, etc. - no action required.
7	Debug	Debug	Debug-level messages.	Info useful to developers for debugging the application, not useful during operations.

Table 25. Severity Level

For example the priority value for a debug message from GNSS will be:

```
Priority = (1*8) + 7 = 15
```

11.2.3: Header

The following sections describe what the header part will contain.

11.2.3.1: Timestamp

- Timestamp – UTC date and time at which message was generated in the format `YYYY-MM-DDTHH:MM:SSZ` derived from GNSS, where,
  - YYYY is the year
  - MM is the month
  - DD is the date
  - T specifies time format is UTC
  - HH is the 24 hour format
  - MM is minutes
  - SS is seconds
  - Z specifies UTC is the preferred reference point

On boot the timestamp starts incrementing from a nominal time zero (1 Jan 2015 10am) and then jumps to the correct GNSS derived time once GNSS is acquired.

11.2.3.2: Hostname

Hostname – either the hostname of the BRM, or IP address if the hostname is not known.

11.2.3.3: APP-NAME

The APP-NAME field identifies the module which generated the syslog message and is in the form of a string.

Module Name	Description
System	System Messages

Module Name	Description
Barracuda	Barracuda Application Server (BAS) messages
GNSSModule	GNSS Manager messages
NOR Flash	NOR flash module messages
NANDFlash	NAND flash module messages
GPIO	GPIO module messages
Ethernet	Ethernet module messages
LuaCore	Lua Core (BAS) messages
LuaUser	Lua User messages (Not Used – Reserved)
ProtocolS	Protocol stack messages
DspApp	Dsp application messages
NetworkApps	Dsp system messages
DevAssert	Assert messages
ATHandler	AT Handler module messages
BuiModule	BUI module messages
DHCPRelay	DHCP Relay Signalling messages

Table 26. APP-NAME Field Values

11.2.4: Message

Message part will first contain the processor CoreId information followed by the log message:

```
<CoreId><SystemTimerCount><Message Content>
```

Where

- <CoreId> – Number identifying the OMAP core where the message came from
- <SystemTimerCount> Value read from the system timer. The system timer is an internal counter allowing sequence of events to be understood.

11.2.4.1: Processor Core

Core Id	Description
1	Core on OMAP1
2	Core on OMAP2

Table 27. Processor Core

The text message format will be in plain ASCII.

11.2.5: Protocol

Syslog messages are sent using UDP with the data sent in plain ASCII text with port number 514.

A syslog originator running on the BRM will attempt to connect to a syslog server on the local Ethernet port, and then send the syslog messages to the server.

The syslog receiver IP address is required to be specified in the Syslog on command.

11.2.6: Examples of Syslog Data

11.2.6.1: GNSS Error

The syslog message will be:

```
<11> 2014-09-24T13:22:05Z 192.168.001.008 1 GnssModule: 1 887113842
GNSS error
```

Where:

- Facility: 1, Severity: 3 which gives PRI = (1*8) + 3 = 11
- Date Time is 13:22:05 24th September 2014
- Hostname – ip address
- Core – 1 (OMAP1)

11.2.6.2: AT Command Received

<17> 2014-09-24T13:22:05Z 192.168.001.008 ATHandler: 1 887113842 CGMRAT Resp: ATE0 5

11.2.6.3: Firmware Upgrade

```
<14> 2014-09-24T13:22:05Z 192.168.001.008 System: 1 887113842
fwUpgrade Start mask 2
```

```
<14> 2014-09-24T13:22:05Z 192.168.001.008 System: 1 887113842
fwUpgrade Program Image 1
```

```
<14> 2014-09-24T13:22:05Z 192.168.001.008 System: 1 887113842
fwUpgrade Complete
```

11.2.6.4: Protocol Stack – Registration Process Example

<14> 2014-09-24T13:22:05Z 192.168.001.008 ProtocolS: 1 887113842 AL S REGM IDLE_AWAIT_PLMN_DISCOVERY IDLE_AWAIT_PLMN_DISCOVERY Initialisation

<14> 2014-09-24T13:22:05Z 192.168.001.008 ProtocolS: 1 887113842 AL S GMMH GMMH_IDLE GMMH_IDLE Initialisation

<14> 2014-09-24T13:22:05Z 192.168.001.008 ProtocolS: 1 887113842 AL S RBC_PS IDLE IDLE Initialisation

AL S SSR IDLE IDLE Initialisation

<14> 2014-09-24T13:22:05Z 192.168.001.008 ProtocolS: 1 887113842 AL S REGM

<14> 2014-09-24T13:22:05Z 192.168.001.008 ProtocolS: 1 887113842 IDLE_AWAIT_PLMN_DISCOVERY IDLE_AWAIT_PSAB_DISCOVERY SIG_PLMN_SEARCH_REQ

<14> 2014-09-24T13:22:05Z 192.168.001.008 ProtocolS: 1 887113842 AL S REGM IDLE_AWAIT_PSAB_DISCOVERY IDLE_AWAIT_SYSTEM_INFORMATION SIG_CBCT_DISCOVER_CNF

<14> 2014-09-24T13:22:05Z 192.168.001.008 ProtocolS: 1 887113842 AL S REGM IDLE_AWAIT_SYSTEM_INFORMATION IDLE_AWAIT_PLMN_DISCOVERY Rx sys info completes PLMN search

<14> 2014-09-24T13:22:05Z 192.168.001.008 ProtocolS: 1 887113842 AL S REGM IDLE_AWAIT_PLMN_DISCOVERY IDLE_AWAIT_PSAB_DISCOVERY SIG_PLMN_SEARCH_REQ

<14> 2014-09-24T13:22:05Z 192.168.001.008 ProtocolS: 1 887113842 AL S REGM IDLE_AWAIT_PSAB_DISCOVERY IDLE_AWAIT_SYSTEM_INFORMATION SIG_CBCT_DISCOVER_CNF

<14> 2014-09-24T13:22:05Z 192.168.001.008 ProtocolS: 1 887113842 AL S REGM IDLE_AWAIT_SYSTEM_INFORMATION IDLE_AWAIT_PLMN_DISCOVERY Rx sys info completes PLMN search

<14> 2014-09-24T13:22:05Z 192.168.001.008 ProtocolS: 1 887113842 AL S REGM IDLE_AWAIT_PLMN_DISCOVERY IDLE_AWAIT_PSAB_DISCOVERY SIG_PLMN_SEARCH_REQ

<14> 2014-09-24T13:22:05Z 192.168.001.008 ProtocolS: 1 887113842 AL S REGM IDLE_AWAIT_PSAB_DISCOVERY IDLE_AWAIT_SYSTEM_INFORMATION SIG_CBCT_DISCOVER_CNF

<14> 2014-09-24T13:22:05Z 192.168.001.008 ProtocolS: 1 887113842 AL S REGM IDLE_AWAIT_SYSTEM_INFORMATION IDLE_AWAIT_POSITION Rx sys info - GNSS position requested

<14> 2014-09-24T13:22:05Z 192.168.001.008 ProtocolS: 1 887113842 AL S REGM IDLE_AWAIT_POSITION IDLE_AWAIT_PSAB_DISCOVERY In > 1 highest preference level spot beam - search for candidate bearer

<14> 2014-09-24T13:22:05Z 192.168.001.008 ProtocolS: 1 887113842 AL S REGM IDLE_AWAIT_PSAB_DISCOVERY IDLE_AWAIT_SYSTEM_INFORMATION SIG_CBCT_DISCOVER_CNF

<14> 2014-09-24T13:22:05Z 192.168.001.008 ProtocolS: 1 887113842 AL S REGM IDLE_AWAIT_SYSTEM_INFORMATION IDLE_NETWORK_FOUND Rx sys info - network found

<14> 2014-09-24T13:22:05Z 192.168.001.008 ProtocolS: 1 887113842 AL S GMMH GMMH_IDLE GMMH_AWAIT_SIG_CONN_EST SIG_GMMAL_EST_REQ

AL S REGM IDLE_NETWORK_FOUND REGISTERING_AWAIT_GPS_POSITION GPS position requested

<14> 2014-09-24T13:22:05Z 192.168.001.008 ProtocolS: 1 887113842 AL S REGM REGISTERING_AWAIT_GPS_POSITION REGISTERING_AWAIT_RESPONSE Register PDU sent to network

<14> 2014-09-24T13:22:05Z 192.168.001.008 ProtocolS: 1 887113842 AL S REGM REGISTERING_AWAIT_RESPONSE REGISTERING_AWAIT_CREATE CreateReq sent to BCn

<14> 2014-09-24T13:22:05Z 192.168.001.008 ProtocolS: 1 887113842 AL S SSR IDLE CONNECTED SSR_CONNECT_REQ received

<14> 2014-09-24T13:22:05Z 192.168.001.008 ProtocolS: 1 887113842 AL S REGM REGISTERING_AWAIT_CREATE REGISTERING_AWAIT_CONNECT BCn SAP created successfully

<14> 2014-09-24T13:22:05Z 192.168.001.008 ProtocolS: 1 887113842 AL S GMMH GMMH_AWAIT_SIG_CONN_EST GMMH_CONNECTED InitialDirectTransfer sent

<14> 2014-09-24T13:22:05Z 192.168.001.008 ProtocolS: 1 887113842 AL S RBC_PS IDLE CONNECTED REGM_CONN_IND

<14> 2014-09-24T13:22:05Z 192.168.001.008 ProtocolS: 1 887113842 AL S REGM REGISTERING_AWAIT_CONNECT REGISTERED_RRC_CONNECTED SSR connected and regMode = 3 in RegisterAck

<14> 2014-09-24T13:22:05Z 192.168.001.008 ProtocolS: 1 887113842 AL S GMMH GMMH_CONNECTED GMMH_IDLE REGM_REL_IND

12: RF Test Interface

This section describes the BRM's RF test interface. The interface allows the BRM and terminal's Air Interface to be controlled independently of the BRM's BGAN protocol stack. It is intended for use in FEM and terminal development, approval and manufacturing test.

The RF test interface is enabled through the bui_mode (set to `true`) configuration setting and puts the BRM, once rebooted, into a test mode providing direct access to control and read data from the BRM's Physical Layer (PHY). If the BRM is rebooted whilst in RF test mode the BRM will revert to its normal operating mode.

The interface allows the VAM to:

> Undergo Inmarsat defined Mandatory Test Requirement (MTR) testing using a BPLT or BGAN Multi-Layer Channel Platform (BMCP) Physical layer tester available from Square Peg Communications Incorporated (SPCI). For the receiver MTR tests include: tuning, frame acquisition, PER testing, selectivity, dynamic range, C/No measurement and code rate detection. For the transmitter MTR tests include: EIRP determination and stability, transmitter off levels, spurious and harmonics, phase noise, tuning performance, frequency accuracy, modulator performance, burst characteristics, coding, and power spectral density

> Perform antenna cable calibration

The test interface is defined within the SPCI document *BPLT/UT Interface Specification* (DC-210295).

13: RF Power and FEM Interface

This section describes the RF power and FEM interface supported by the BRM and provides specific voltage, timing and circuit recommendations for each interface.

The interface allows the BRM to be used with a wide range of alternative RF front-end configurations and components. This flexibility allows the BRM to be used in a broad range of BGAN applications and terminals using a range of antennas. These configurations include:

- Integrated terminals
- Terminals with remote antennas often connected with a single coaxial cable
- Use with an electronic steered (phase array) antenna
- Use with a mechanically steered passive antenna

13.1: Pin Configuration: RF Power and FEM Interface

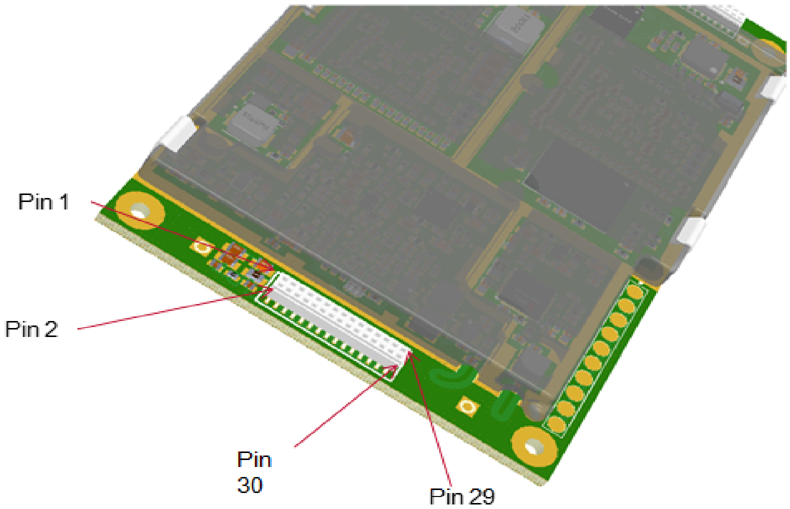


Figure 20. Pin out of the BRM RF power and FEM interface connector (bottom view)

13.2: RF Power and FEM Interface Connector Pin Description

The following table lists the pin name, direction, function, interface and required termination if unused of the RF power and FEM interface connector.

Pin	Name	Group	I/O	Description	Voltage	If unused
1	VIN_5V5_RF	Power		RF sub-system supply	VIN_5V5_ RF	Must be used
2	VIN_5V5_ RF	Power		RF sub-system supply	VIN_5V5_ RF	Must be used
3	VIN_5V5_ RF	Power		RF sub-system supply	VIN_5V5_ RF	Must be used
4	VIN_5V5_ RF	Power		RF sub-system supply	VIN_5V5_ RF	Must be used
5	GND	Ground		Ground		Ground

Pin	Name	Group	I/O	Description	Voltage	If unused
6	GND	Ground		Ground		Ground
7	GND	Ground		Ground		Ground
8	HPA_PSU_EN	HPA	O	Enable HPA power supply	VCC_3V3	
9	GND	Ground		Ground		Ground
10	GND	Ground		Ground		Ground
11	GND	Ground		Ground		Ground
12	HPA_Bias	HPA	O(a)	HPA Bias	VCC_3V3	Leave open
13	GND	Ground		Ground		Ground
14	GND	Ground		Ground		Ground
15	GND	Ground		Ground		Ground
16	LNA_EN	LNA	O	Enable LNA	VCC_3V3	Leave open
17	GND	Ground		Ground		Ground
18	GND	Ground		Ground		Ground
19	GND	Ground		Ground		Ground
20	FEM_RESET	FEM_CTRL	O		VCC_3V3	Ground
21	GND	Ground		Ground		Ground
22	FEM_INT	FEM_CTRL	I		VCC_3V3	Leave open
j23	GND	Ground		Ground		Ground
24	FEM_READY	FEM_CTRL	I		VCC_3V3	Leave open
25	GND	Ground		Ground		Ground
26	GND	Ground		Ground		Ground
27	GND	Ground		Ground		Ground
28	I2C1_SCL	I2C	O		VCC_3V3	Leave open
29	GND	Ground		Ground		Ground
30	I2C_SDA	I2C	I/O		VCC_3V3	Leave open

Table 28. RF power and FEM interface connector pin description

13.2.1: Absolute Maximum ratings

Stress above one or more of the limiting values may cause permanent damage to the device. Exposure to limiting values for extended periods may affect device reliability.

Parameter	Min	Max	Units	Notes
HPA_PSU_EN, LNA_EN	-0.3	3.6	V	With respect to ground
FEM_RESET, FEM_INT, FEM_READY, I2C1_SCL, I2C_ SDA	-0.3	3.6	V	With respect to ground

Table 29. RF power and FEM interface absolute maximum ratings

13.3: HPA Control

HPA_PSU_EN is provided to enable an external HPA power supply. When the BRM raises this to HIGH, this is a request that the HPA Power Supply needs to be enabled.

HPA_Bias is an enable signal for the FEM's HPA bias.

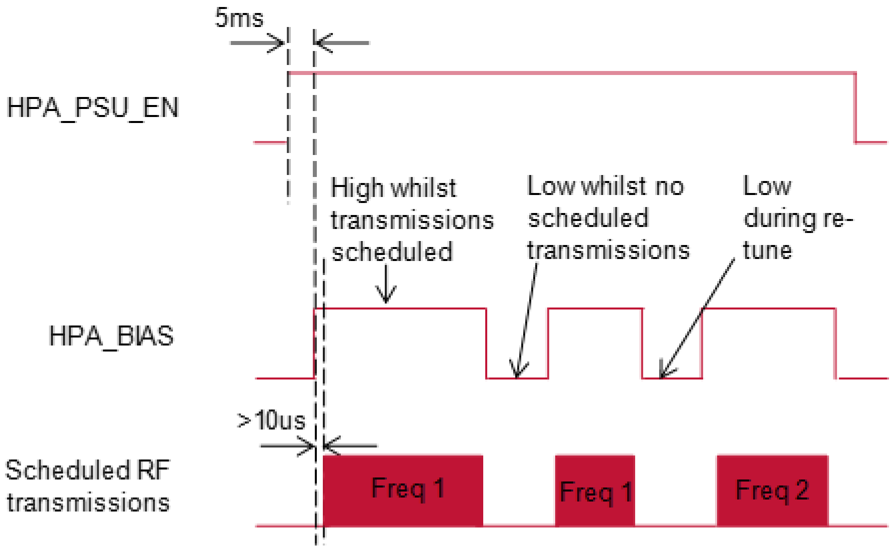


Figure 21. HPA Control Timing

FEM_READY is a digital signal from the FEM to the BRM. When the FEM raises this to HIGH, the FEM is indicating that the FEM is ready for use, i.e., the FEM processor is booted, the HPA Power Supply can be enabled, that the FEM is within temperature limits and that there are no other known problems. If FEM_READY is low, the BRM assumes that the FEM is not ready for use. If so, the BRM may take action such as resetting the FEM and trying again.

Note: The HPA control interface is unpowered when the BRM is in low power or sleep power mode (Refer to **System Power Modes**). To avoid "self-powering", no pull up resistors to an active supply should be used.

13.4: LNA Control

LNA_EN is provided to enable/disable an external LNA. When the BRM raises this to HIGH, this is a request that the LNA needs to be enabled. When the BRM lowers it to LOW, this is a request that the LNA needs to be disabled.

Note: The LNA control interface is unpowered when the BRM is in low power or sleep power mode (Refer to **System Power Modes**). To avoid "self-powering", no pull up resistors to an active supply should be used.

13.4.1: FEM Control

The BRM provides an interface to allow a FEM to be reset. The FEM_RESET signal is driven low to reset the FEM.

An I²C interface is provided by I²C1_SCL and I²C1_SDA. It is the main communications channel between the BRM and FEM. Information exchanged includes:

> FEM gain information to the BRM for receive, transmit and the transmit power sense including antenna information allowing the terminal to meet the class specific RF requirements

> FEM temperature and FEM over-temperature conditions

> Terminal class information, including HDR and LDR capabilities

> Terminal TAC code and FEM serial number

> Communicate information relevant to antenna steering

> Optionally ramp the HPA

This is a standard I^2C interface, dedicated to the FEM. The BRM provides a standard, fast mode (400 kHz) I^2C master interface with 1K pull up resistors to VCC_3V3 in the BRM.

FEM_INT is a digital signal from the FEM to the BRM. The FEM may at any time raise an interrupt at the BRM allowing communications to be initiated over the I2C interface. The interrupt is cleared through the I2C interface using the interrupt clear register.

Parameter	Symbol	Min	Typ	Max	Units	Notes
Logic low input	V_{IL}			0.8	V	
Logic high input	V_{IH}	2			V	
Logic low output	V_{OL}			0.4	V	I_{OL} = 4mA
Logic high output	V_{OH}	2.4			V	I_{OH} = -4mA

Table 30. FEM control electrical characteristics

14: BGAN RF Interfaces

This section describes the BGAN and GNSS RF interfaces supported by the BRM.

14.1: Pin Configuration: RF Connections

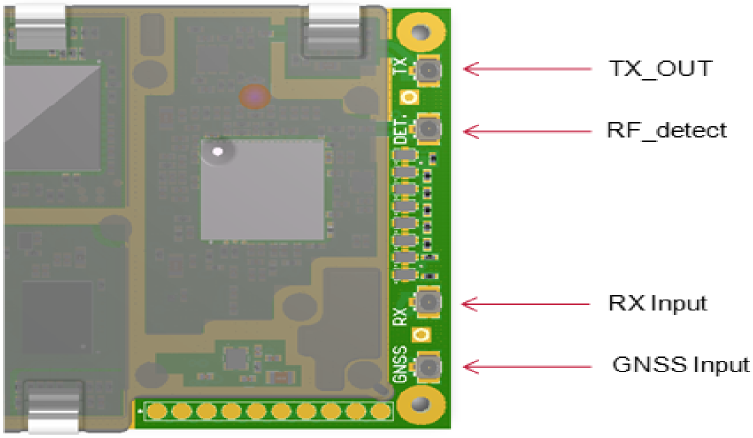


Figure 22. Pin out of the BRM – RF connections (top view)

14.2: Overview

- The TX_OUT is the BGAN transmitter output
- The RF_Detect is an input used for TX power level detection for closed loop transmit power control
- The RX_IN input connection is the BGAN receiver input
- The GNSS_IN input is an independent RF input for the GNSS receiver

14.2.1: Integrated Terminals

For integrated terminals containing a FEM, the RF connections should be directly connected to the FEM, via coaxial connections. This allows the FEM's HPA to be used within the BRM's closed loop transmit power control circuit so that the terminal transmits the correct RF power and meets the class defined nominal EIRP with up to 10dB network defined back off power control.

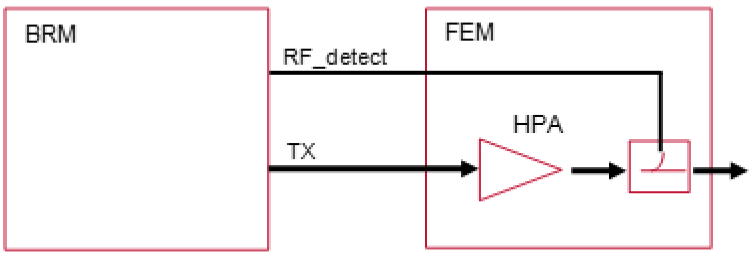


Figure 23. Terminal with closed loop power control incorporating HPA

Frequency and temperature dependent calibration tables are stored in the FEM for:

- The FEM transmit path, BRM transmit port to antenna port gain
- The FEM transmit power sense path, antenna port to BRM RF Detect gain
- Antenna gain

The gain information is used within the BRM's power control loop to set the terminals EIRP. The loop is typically operated in a closed loop configuration where the FEM transmit power sense path and antenna gain tables are used to define the EIRP. In addition the terminal needs to meet the SDM defined class dependent "first burst" EIRP requirements prior to the loop being closed. This "first burst" uses the FEM transmit path gain and antenna gain tables to define the EIRP.

The tables are downloaded from the FEM to the BRM prior to transmission and whenever the FEM signals to the BRM that they have been updated. For a change in operating conditions that affects the FEM transmit gain in a way that means the terminal may not meet its class defined EIRP setting accuracy the table shall be updated by the FEM. For class 1, 2 and 3 terminal FEMs, a 0.5 dB change in gain shall trigger a table update by the FEM.

For a change in operating conditions that affects the FEM transmit gain in a way that means the terminal may not meet its class defined EIRP setting accuracy this table shall be updated by the FEM.

It is anticipated that this gain information will be obtained for each individual unit during production test of the FEM with any temperature dependence of the gain determined through characterisation during development of a small number of FEMs.

14.2.2: Terminals With Remote Active Antennas

For FEMs contained within a remote active antenna, it is typically not possible to use the FEM's HPA within the BRM's closed loop transmit power control circuit. A FEM interfacing circuit, located near the BRM should be used to feedback a portion of the transmit signal to the BRM's RF_Detect input closing the transmit power control loop so that the terminal transmits a defined RF power. A fixed gain HPA should then be used to amplify the signal to meet the class defined EIRP.

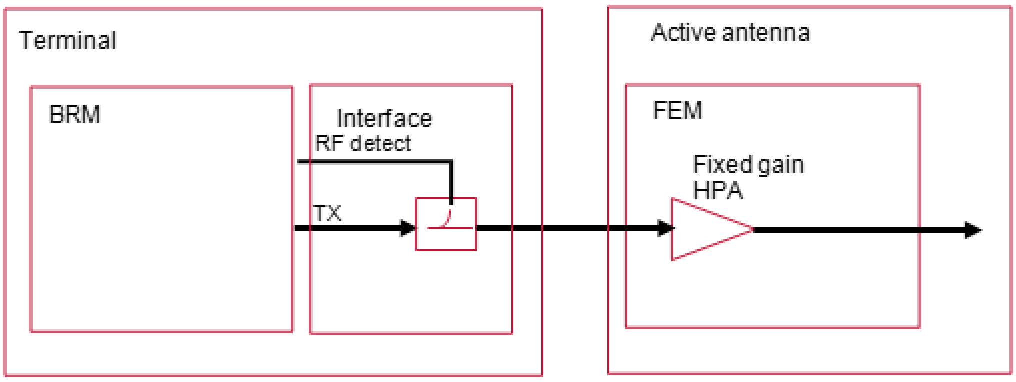


Figure 24. Terminal With External Fixed Gain HPA

In this case the calibration tables are stored in the interface unit with the FEM transmit path and power sense path tables being used by the BRM to define the RF power at the interface output. The gain of the HPA, any interface unit to FEM cable loss and the antenna gain should all be incorporated into the antenna gain calibration table.

14.2.3: Absolute Maximum Ratings

Stress above one or more of the limiting values may cause permanent damage to the device. Exposure to limiting values for extended periods may affect device reliability.

Parameter	Min	Max	Units	Notes
RF input power on RX_IN		15	dBm	
DC voltage on RX_IN		5.5	V	AC coupled with 100pF capacitor
RF input power on RF_Detect		18	dBm	
DC voltage on RF_ Detect		5.5	V	AC coupled with 100pF capacitor
DC voltage on TX_OUT		5.5	V	AC coupled with 100pF capacitor
RF input power on GNSS_IN		15	dBm	
DC voltage on GNSS_IN		5.5	V	AC coupled with 100pF capacitor

Table 31. Absolute Maximum Ratings - BGAN RF

14.3: BGAN Connections

14.3.1: TX_OUT Parameters

Parameter	Min	Typ	Max	Units	Notes
Frequency	1626.5		1675	MHz	Excludes 1660.5MHz to 1668MHz
BRM nominal output level (to obtain nominal terminal EIRP)	0		10	dBm	The TX_OUT output level varies according to the level of the feedback detected at the RF_DETECT input as a closed loop function.
BRM output setting range	Nominal output level - 10		Nominal output level - 0	dB	The terminal's EIRP is set by the network. The terminals setting range may vary between the terminals nominal EIRP and nominal EIRP -10dB (Class 3 nominal EIRP -6dB).
EVM		2.5	4.5	%	

Parameter	Min	Typ	Max	Units	Notes
Spurii (<10MHz offset from carrier)			-70	dBc	
Spurii (>10MHz offset from carrier)			-64	dBc	Spur mitigation required for Classes 1, 3, and 8. Refer to **Transmitter Emissions**.
S22 output match			-10	dB	
EIRP setting accuracy – first burst	-2		+1	dB	With BRM operating in closed loop configuration.
EIRP setting accuracy – subsequent bursts	-1		+1	dB	With BRM operating in closed loop configuration

Table 32. TX_OUT Parameters

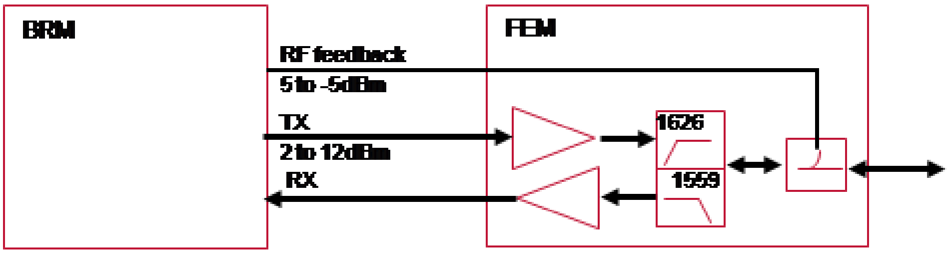


Figure 25. TX output level control with HPA in feedback loop

14.3.2: RF_Detect Parameters

Parameter	Min	Typ	Max	Units	Notes
Frequency	1626.5		1675	MHz	Excludes 1660.5MHz to 1668MHz.
Input Level	-11.5		12.5	dBm	Input level to be within the defined range over the terminals entire EIRP setting range.
S11 input match			-10	dB	

Table 33. RF_DETECT Parameters

14.3.2.1: Typical Performance Characteristics

Input return loss versus frequency.

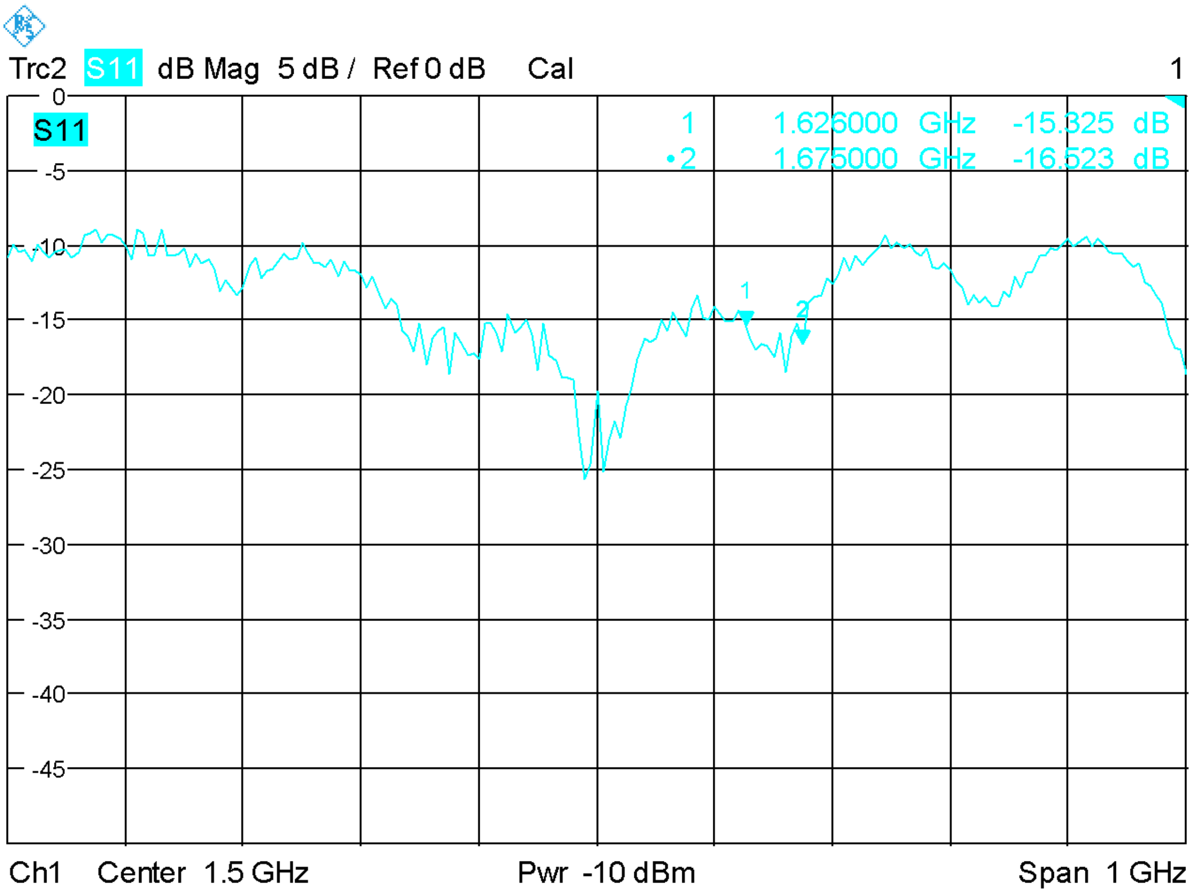


Figure 26. Input return loss versus frequency

14.3.3: Transmitter Emissions

The BRM is designed to meet EN301 444 [2], EN301 681 [3] and EN301 473 for the BRM's full range of transmit nominal output power levels with the transmit output level control incorporating the HPA in the BRM's transmit feedback loop.

Transmitter emissions performance assumes the use of a FEM with transmit SAW filtering and ceramic duplex filter. Refer to *Transmitter Chain Filtering in BRM-Based BGAN Terminals* and *Front End Module Interface Control Document*, which describe an interface for the FEM to provided filter switching for out-of-band noise reduction (**External Transmit Filtering Control**) in the required classes. This can either be done via the FEM I²C interface or by using BRM GPIO.

The BRM worst case spur performance is -64dBc, which is +/-52MHz from the carrier. Operating at the bottom channel results in a spur at ~1678MHz. Operating at the top channel results in a spur at ~1623MHz. In these instances (for classes 1, 3, 4, 6, 7, 8 and 15), filtering in the FEM is required to reduce this level of spur to acceptable limits for the respective radio standard. For example: For Class 3, at least 6dB of spur attenuation is required for EN301 681 (i.e. <-70dBc or -60dBW max spur level). Similarly, additional filtering is required for aeronautical classes, to ensure compliance in the GNSS bands as specified by ETSI and the FCC. For further details, please refer to *Transmitter Chain Filtering in BRM-Based BGAN Terminals*.

14.3.3.1: Out-of-Band Emissions

Typical out of band noise and spurii profiles of the BRM are shown below. The FEM is expected to provide the additional filtering required to ensure the terminal meets the emissions limits applicable to its class.

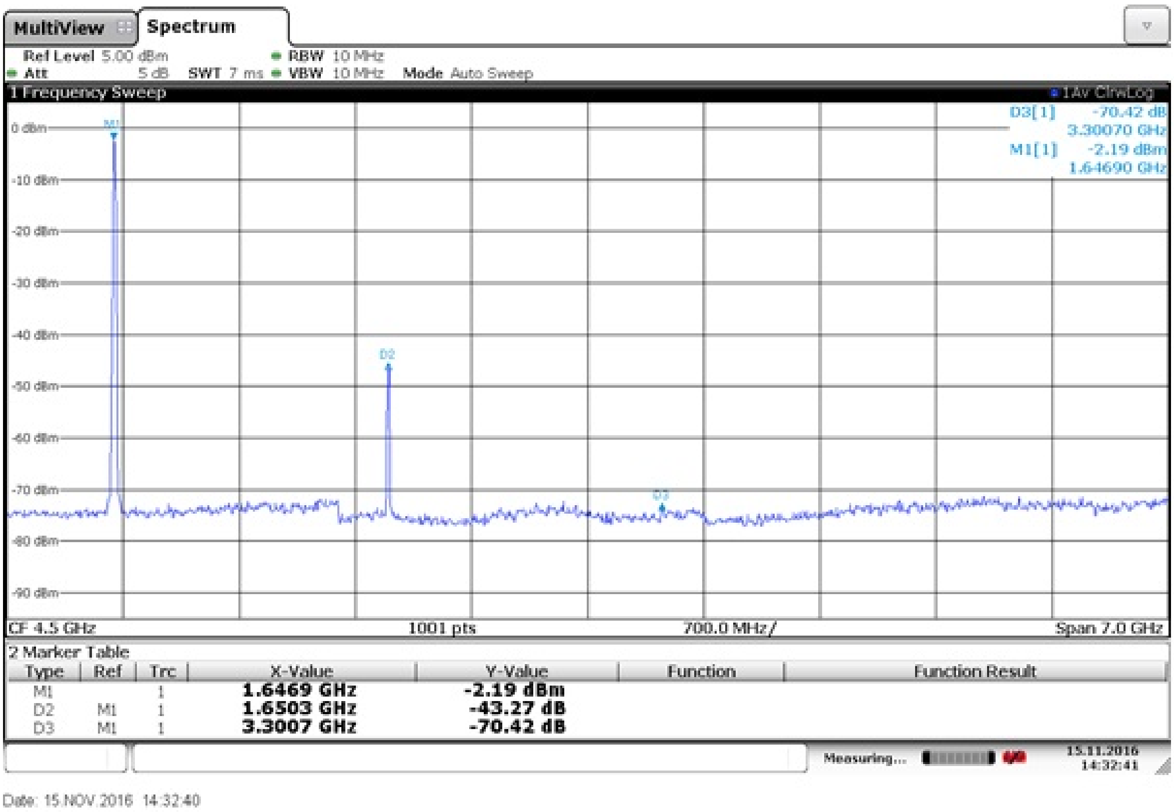


Figure 27. BRM TX_OUT Harmonics: TX CW at 1650MHz

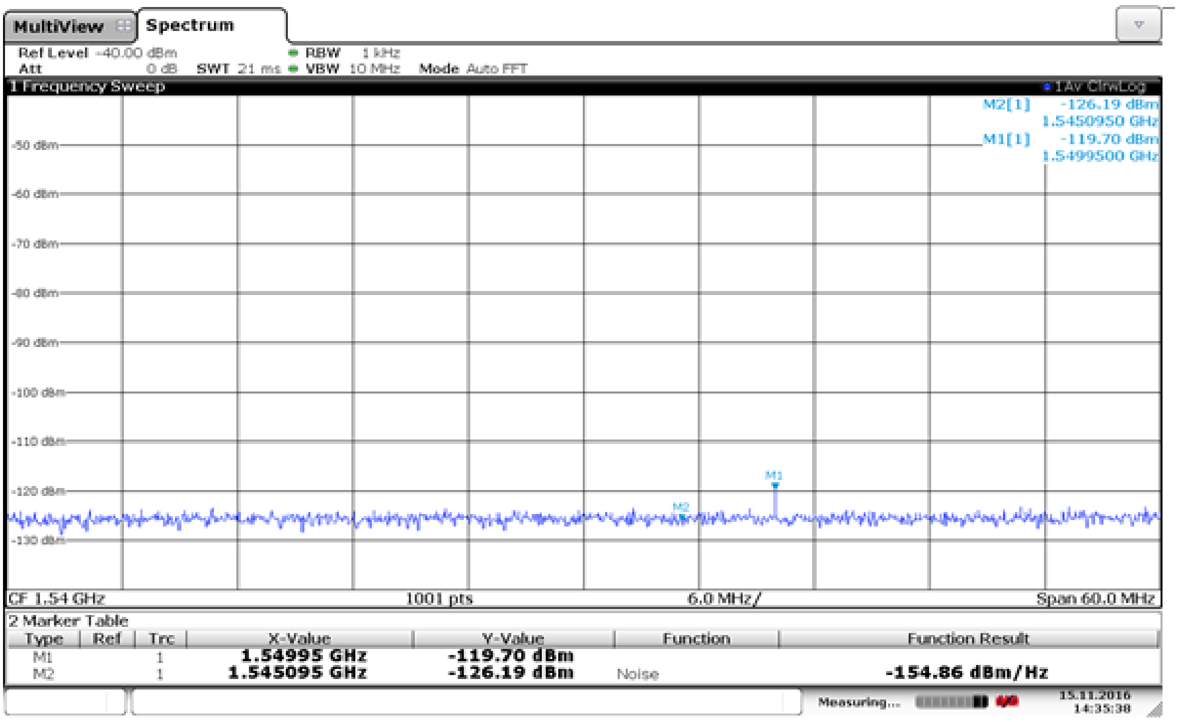


Figure 28. BRM TX_OUT emissions – BGAN RX band (1518MHz - 1559MHz) - TX CW 0dBm at 1650MHz

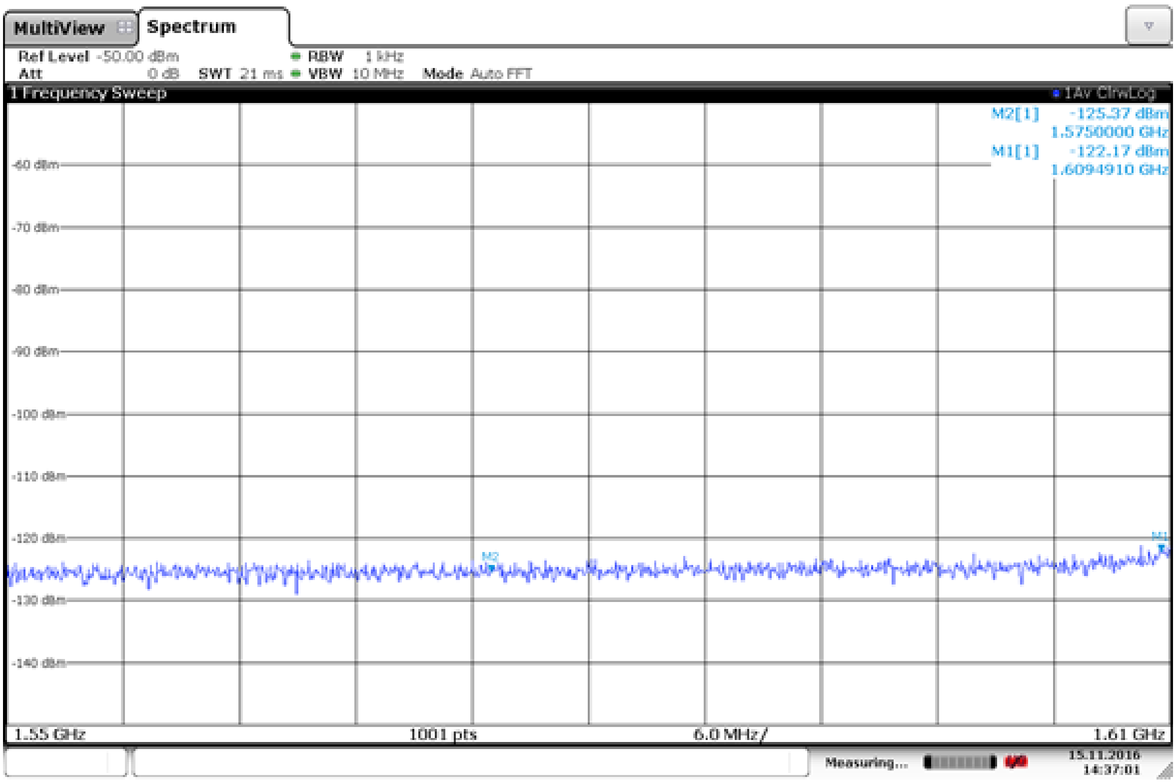


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Figure 29. BRM TX_OUT Emissions – GNSS band (1559MHz to 1610MHz) - TX CW 0dBm at 1626MHz

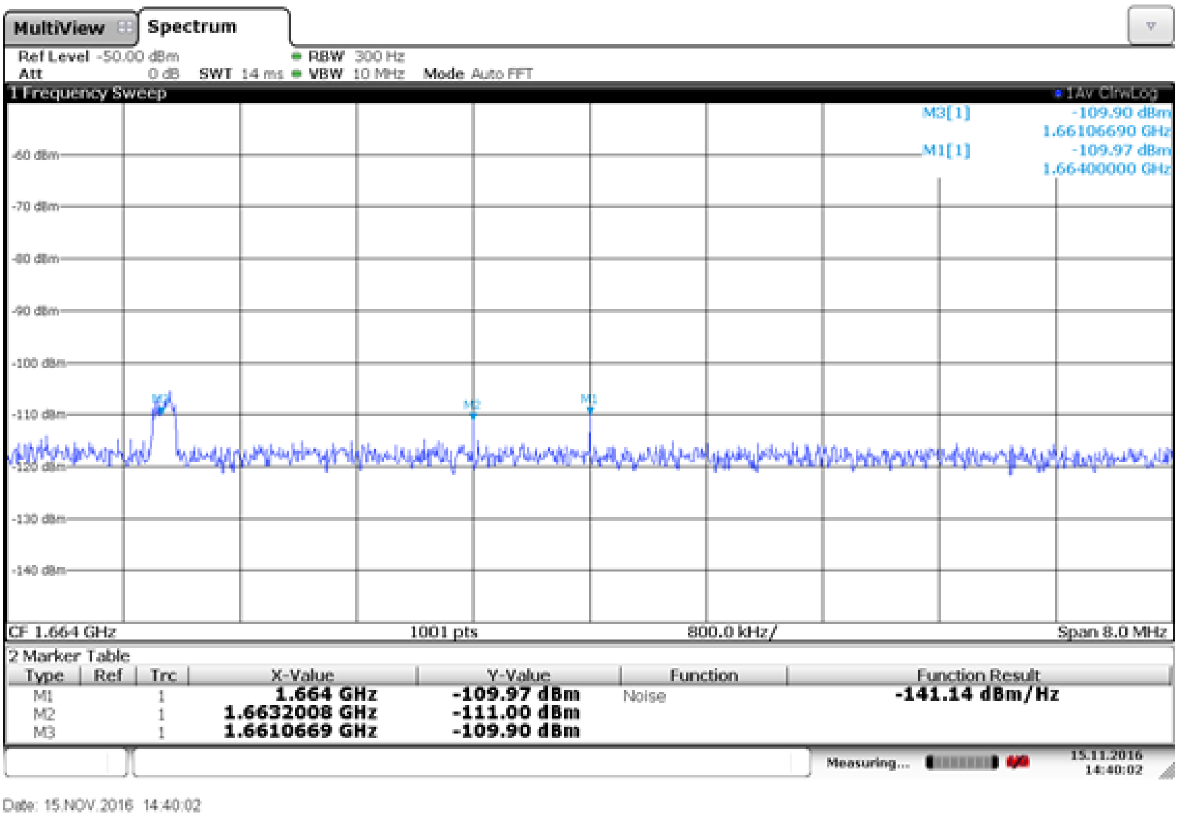
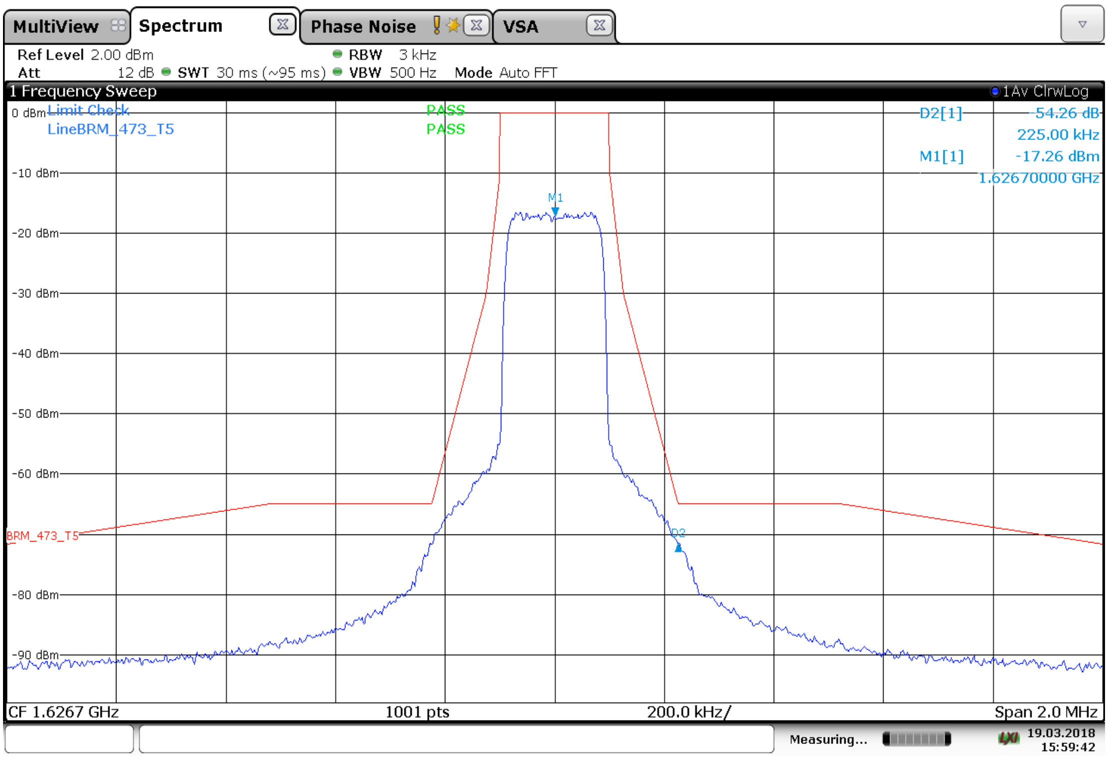


Figure 30. BRM TX_OUT spurii in RA band 1660 - 1668MHz - TX CW 0dBm at 1651MHz

14.3.3.2: Transmitter Masks

The transmitter masks for the BRM have been derived from the BGAN system requirements and relevant ETSI standards, with a margin of typically 5dB allowed compared to the toughest requirement (aeronautical classes) for spectral re-growth in the HPA.

Note: The Red line in *Figure 31* shows EN301 473 limit.



15:59:42 19.03.2018

Figure 31. Example BRM Transmitter output for T4.5X bearer (151.2ksym/s, 16-QPSK, α = 0.25). Mask: EN301473 Table 11, normalised for Class 15 (Aeronautical).

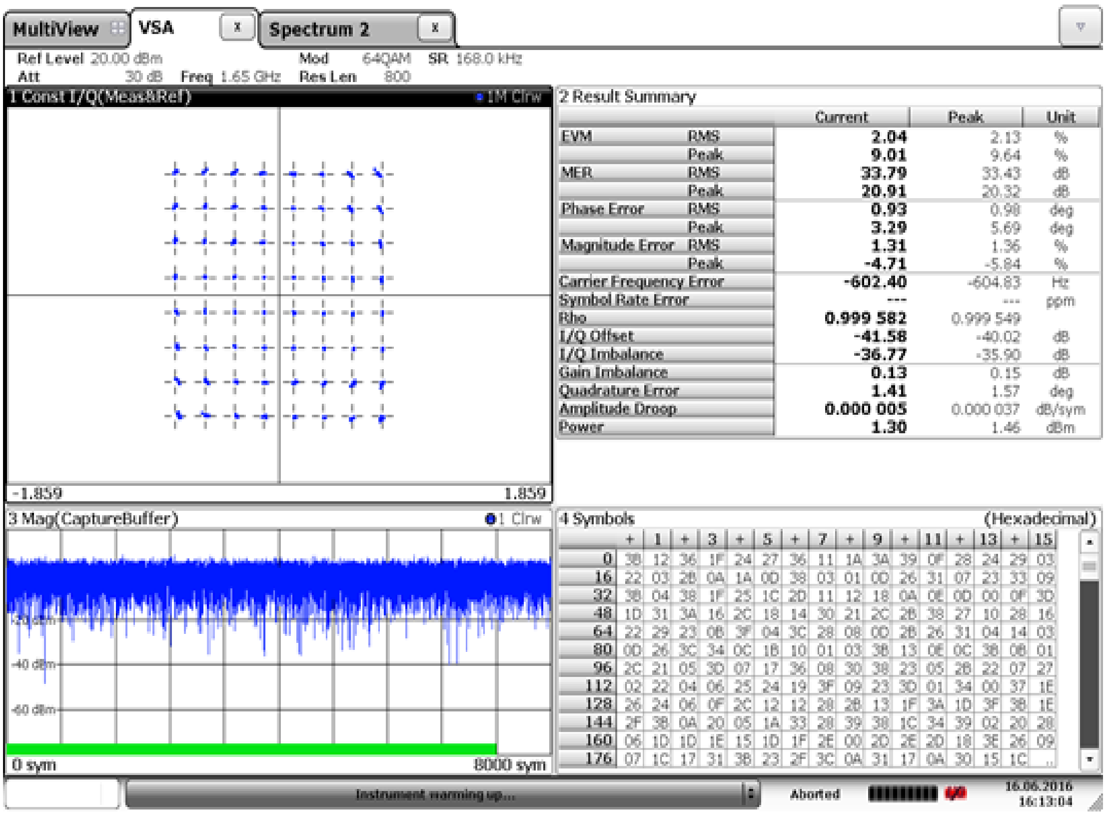


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Figure 32. BRM Transmitter Typical EVM for T5X64 bearer (168ksym/s, 64-QPSK, α = 0.13)

14.3.4: Receiver Input (RX_IN)

This is specified as the received signal input to the BRM from the FEM over which the BRM can meet the BGAN receiver performance standards.

Parameter	Min	Typ	Max	Units	Notes
Frequency	1518		1559	MHz	
In band S11 Input Match		-10		dB	
Noise Figure – High Gain		10		dB	Full duplex operation.
Noise Figure – Low Gain		19		dB	In the presence of an in-band interferer at -45dBm at the reference (non-ATC compliant) FEM input. For an ATC compliant FEM, low gain is not used because protection from large interferers is provided by the FEM.
Global beam signal level	-118.2		-87.5	dBm	
Regional beam signal level	-113.2		-82.5	dBm	
Spot beam signal level	-100		-67.5	dBm	
Max Out of Band signal (>1000MHz)			-38.6	dBm	Linearly extrapolated between 1000MHz and 1400MHz
Max Out of Band signal (<1400MHz)			-41.5	dBm	Linearly extrapolated between 1000MHz and 1400MHz
Max Out of Band signal (>1626MHz)			-42.8	dBm	Linearly extrapolated between 1626MHz and 4000MHz
Max Out of Band signal (<4000MHz)			-50.7	dBm	Linearly extrapolated between 1626MHz and 4000MHz

Table 34. RX_IN

14.3.4.1: Typical Performance Characteristics

Input return loss versus frequency.

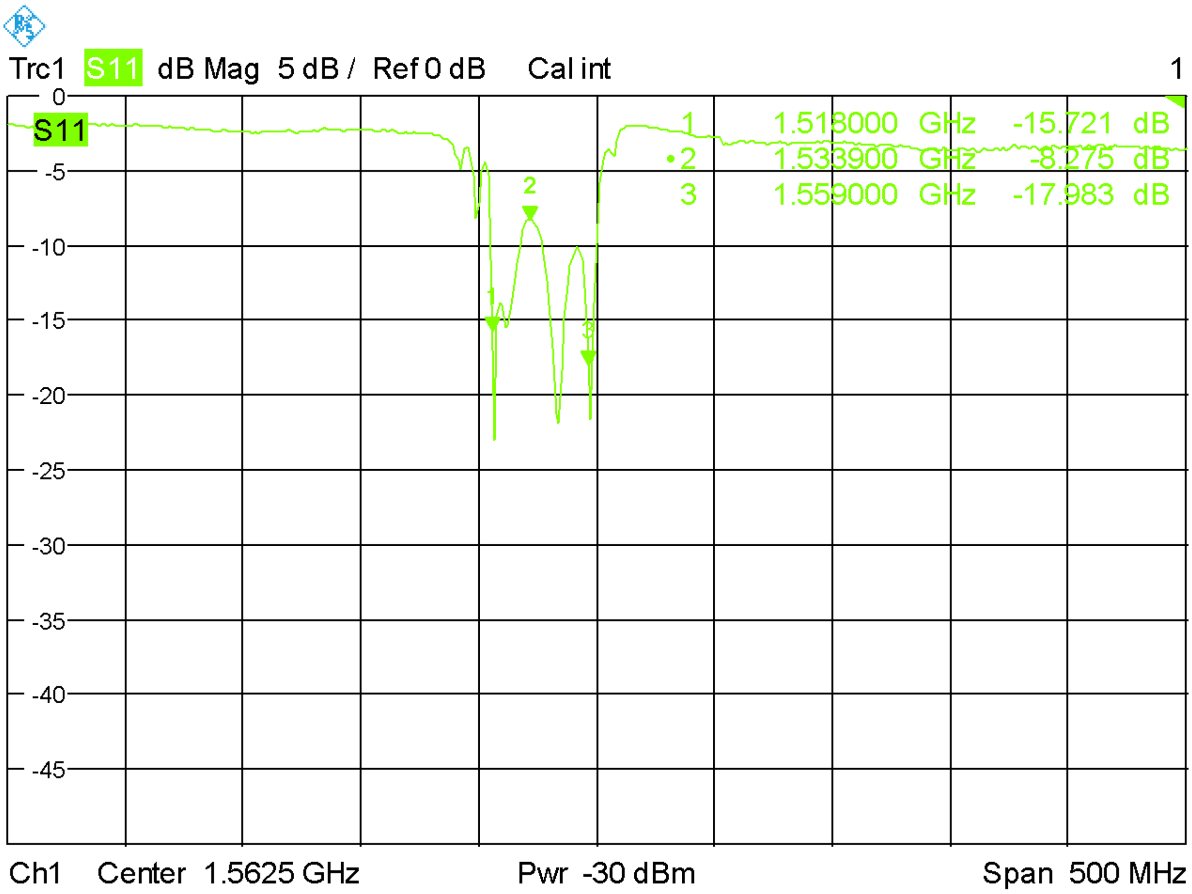

Figure 33. Input return loss versus frequency

14.4: GNSS_IN

Parameter	Min	Typ	Max	Units	Notes
Frequency	1559		1610	MHz	
In band S11 Input return loss			-10	dB	
External gain			50	dB	As specified by GNSS chipset manufacturer. The BRM's GNSS receiver includes BGAN transmission filtering at the GNSS receiver input. If GNSS operation is required during BGAN transmissions care should be taken that suitable filtering is added to avoid compromising GNSS performance during BGAN transmission.
Noise Figure		8		dB	

Table 35. GNSS_IN

14.4.1: Typical Performance Characteristics

Input return loss versus frequency.

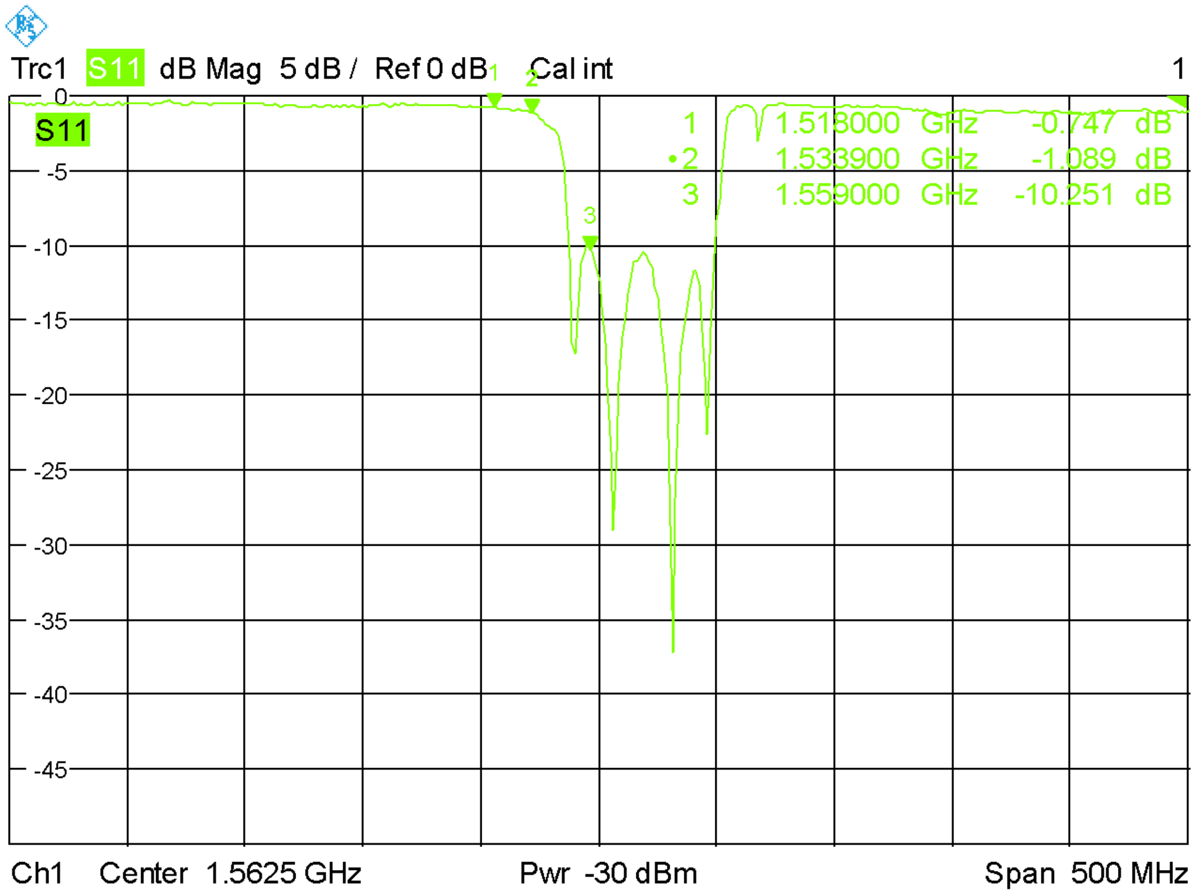

Figure 34. Input return loss versus frequency

14.5: RF Port Isolation Requirements

To avoid system self-blocking problems, the BRM requires from the FEM:

- >40dB of isolation between FEM TX_IN and FEM RX_OUT, in the RX Band (1518 – 1559MHz)
- >30dB of isolation between FEM TX_ IN and FEM RX_ OUT, in the TX Band (1626.5 – 1675MHz)
- >65dB of isolation between FEM TX_ IN and FEM GNSS_ OUT (in the band 1560-1610MHz)
- >20dB of isolation between FEM TX_ IN and FEM GNSS_ OUT (in the band 1626.5-1675MHz)
- >55dB of isolation between FEM RF_DETECT and FEM GNSS_ OUT (in the band 1560-1610MHz)

15: Routing Constraints and Recommendations

This section provides general PCB routing constraints and recommendations for the BRM's application board.

Note: This is a non-exhaustive list of suggested design guidelines. The developer is responsible for deciding whether to implement these guidelines.

15.1: General Rules and Recommendations

All external interface signals including UARTS, Ethernet and USIM should be routed as far as possible from the BRM FEM control signals and power supplies.

15.2: Ground Plane and Shielding Traces

100% ground plane is required under the BRM.

15.3: Power Supply

The power supply is one of the key design considerations in the development of a BGAN terminal incorporating the BRM.

Special care must be taken in such design in order to minimise the possible effects in the following key performance areas of the terminal:

- EMC performance
- The emission spectrum
- Receive sensitivity at one or more frequencies

15.4: Application PCB Recommendations

A design documentation pack for the HDK mother board is available for use as a reference for the design and development of the VAM's application board. The pack includes:

- Schematics (pdf and Altium formats);
- PCB layout (ODB++ and Altium formats);
- Bill of Materials

15.5: Connections to the FEM

Recommendations below are for cases where the FEM is mounted in close proximity to the BRM and its application board.

15.6: External Interfaces

15.6.1: Ethernet Interface

Transformer-less Ethernet is not recommended.

15.7: EMC and ESD Recommendations

EMC tests have to be performed on the application as soon as possible to detect any potential problems. When designing, special attention should be paid to:

- Possible spurious emissions radiated by the application to the RF receiver in the receiver band
- ESD protection on the BRM's application board is mandatory on all signals which are externally accessible

16: BRM Terminal Class and Operation

With an appropriate FEM and antenna the BRM may operate in any Land Portable, Maritime, Land Mobile or Aeronautical BGAN terminal class. The following information should be programmed into the FEM by the VAM. It is transferred to the BRM through the FEM I^{2}C interface.

Information from FEM	Purpose	Command to read value from BRM
Terminal manufacturer	Identification of terminal manufacturer	+CGMI, RESTful
Model Identification	Identification of terminal model	+CGMM, RESTful
Revision identification	Identification of terminal revision	+CGMR, RESTful
Terminal serial number	A 6 digit terminal serial number is combined with the terminal models TAC code to form the terminals IMEI as defined in 3GPP TS 23.003. TAC codes may be obtained from the BABT.	+CGSN, RESTful
TAC code		
BGAN class	To define the terminals class of BGAN operation	
HDR capable	Used for the BRM to signal to the network that the terminal is capable (and approved for) HDR operation	
LDR capable	Used for the BRM to signal to the network that the terminal is capable (and approved for) LDR operation	
Sub class	Used for the BRM to signal to the network the terminals subclass of BGAN operation. The sub-class, assigned by Inmarsat defines any variations in the terminal characteristics compared to the base BGAN class.	
Software Version Number	This is used to indicate to the network the version number of the terminal software. This is a 2-digit number and starts at `00`.	
Service Provider Restriction. USIM Group Identifier 1 – GID1	The GID1 field will restrict the usage of the terminal only with the USIMs supplied by the same Service Provider, by default this should be set to `0xFFFF` meaning that no restrictions are in place.	

Information from FEM	Purpose	Command to read value from BRM
Distribution Partner Restriction. USIM Group Identifier 2 – GID2	The GID2 field will restrict the usage of the terminal only with the USIMs supplied by the same Distribution Partner, by default this should be set to `0xFFFF` meaning that no restrictions are in place.	
Restricted Product USIM Register (GID3)	A USIM elementary file GID3 (0x8F0D) with a value of 0x0100 and above, as assigned by Inmarsat, may restrict the use of a USIM to a specific product. If the terminal is to be used with a restricted product USIM the USIM's reserved EFGID3 value is stored in the FEM. A restricted product USIM will be rejected by any product it is not intended for.	
User-defined Field	Four bytes have been reserved for user defined information. These allow the VAM or FEM manufacturer to signal information through the FEM interface to the user via the BRM's RESTful command interfaces. An example of how the registers may be used is to convey battery charge information.	RESTful
Aero Safety Services (ASS)	Used for the BRM to signal to the network that the terminal has Aero Safety capabilities.	
Enhanced Aero Safety Services (EASS)	Used for the BRM to signal to the network that the terminal supports enhanced safety features and services.	

Table 36. Identity and class configuration

17: Antenna Alignment

For BGAN operation the antenna needs to be aligned towards the satellite and signal strength maximised prior to registering, attaching to the network allowing a service to be provided to the user. The BRM can be used with:

- Fixed antennas, pre-aligned to the satellite
- Omni-directional antennas that do not need specific alignment with the satellite
- Portable equipment antennas manually aligned prior to operation
- Antennas on moving maritime and vehicle platforms automatically aligned to the satellite

Aids are provided through:

- The AT and RESTful interfaces to aid manual pointing of the antenna
- The I²C FEM interface to aid automatic initial alignment and on-going antenna tracking of the satellite as the platform moves. In order to implement automatic antenna steering, the antenna needs to combine the I²C FEM interface information from the BRM with the antenna's current attitude

17.1: Antenna Pointing

Depending on antenna type and class, the following may be applicable:

On power up or when exiting low power mode, the BRM can be configured to enter the initial antenna alignment phase with the BRM in "pointing mode". Once the antenna is believed to be aligned, the terminal can be commanded to exit from pointing mode and will attempt to register with the network.

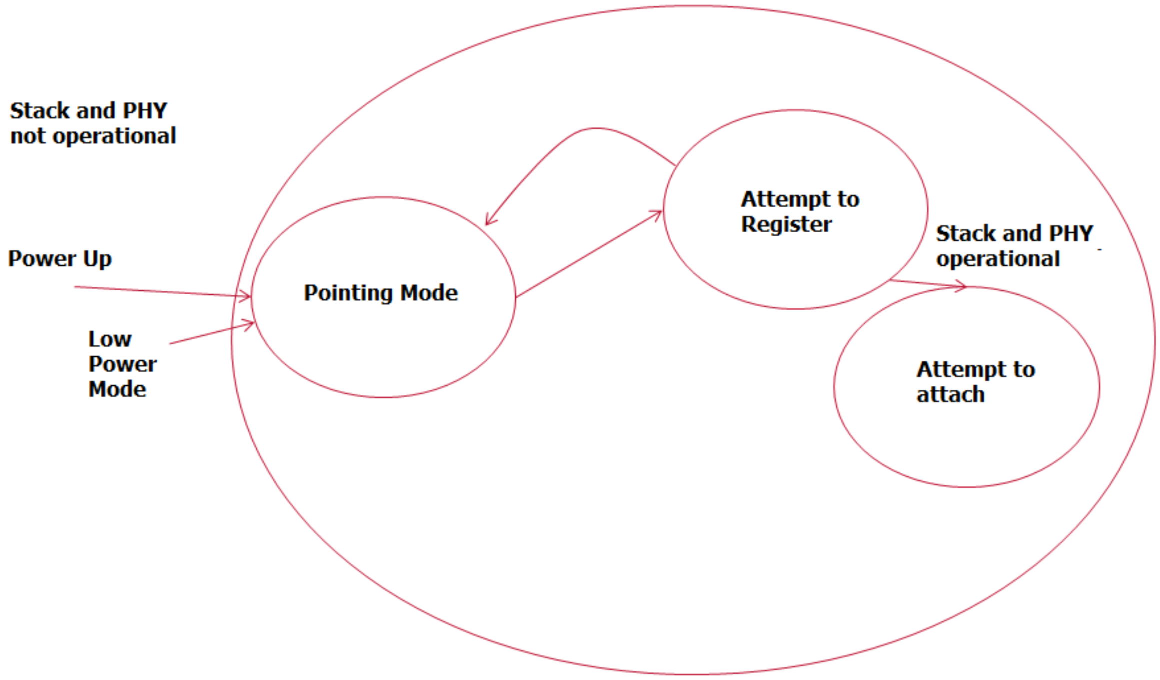

Figure 35. Antenna pointing mode

The status of pointing mode can be read and updated via:

Interface	Command
AT	_IPOINT
Restful	GET /device/antenna_pointing PUT /device/antenna_pointing
Config setting	Read when entering operational power mode instructing the terminal to bypass pointing mode and commence registration

Table 37. Antenna Pointing Commands per Interface Type

17.2: Pointing Aids

At all times when powered, (using stored values if necessary) the BRM provides to the user

- BGAN satellite availability
- BGAN satellites currently visible

When the BRM is attempting to establish a satellite connection or has a connection the BRM provides to the user or automatically steered antenna:

- Current satellite selected
- Signal quality from current satellite

17.3: BGAN Satellite Availability

This aid allows the subscriber to inquire the position on all available BGAN satellites reporting their Satellite ID, longitude, primary global frequency and alternate global frequency.

Interface	Command
AT	_ISATINFO
Restful	/device/satellites_table

Table 38. BGAN Satellite Availability Command per Interface Type

17.4: BGAN Satellite Visible

This aid allows the subscriber to inquire what satellites are visible. For each satellite it reports its ID number, elevation and azimuth.

Interface	Command
AT	_ISATVIS
Restful	/device/satellites_table

Table 39. BGAN Satellite Visible Query Command per Interface Type

17.5: Current Satellite Selected

Information on the current satellite selected is provided through:

Interface	Command
AT	_ISATCUR
Restful	/device/current_satellite
I2C FEM interface	Satellite information registers including the satellites, frequency, elevation and azimuth (referenced to earth coordinates)

Table 40. Current Satellite Selected Query Command per Interface Type

17.6: Signal Quality Indication

When the BRM is operational, the C/No is made available through all interfaces:

Interface	Command
AT	_ISIG
Restful	/device/signalstrength
I2C FEM interface	Signal strength measurement registers beginning at 0x50.
	Current BRM receive frequency (allowing the antenna manufacturer to implement their own receiver to measure signal strength if required.

Table 41. Signal Quality Query Command per Interface Type

18: BGAN Type Approval

Irrespective of whether a FEM for a BGAN Terminal is integrated into the BRM or into the antenna, if the FEM design has performance similar to class-specific antenna with performance as defined in *Table 42*, then the BRM meets the Inmarsat performance requirements for a Class 1, 1 HDR, 2, 3,4,6,7, 8, 9, 10, 11,14 or 15 BGAN terminal.

Note: A BRM operating within a Class 10, or 11, terminal shall have a specified maximum speed of less than 200km/hr.

BGAN class	Description	antenna noise temp [K]	antenna gain [dBi]
1	Land portable high gain	160	15.2
2	Land portable intermediate gain	160	12.2
3	Land portable low gain	160	7.2
4	Aero enhanced low gain	50	1.8
6	Aero high gain	100	11.6
7	Aero intermediate gain	100	5.6
8	Maritime high gain	160	18.7
9, 14 and 14-2	Maritime low gain	160	10.2
10	Land mobile high gain	160	13.2
11	Land mobile intermediate gain	160	9.7
15	aero low gain	25	1.6

Table 42. Antenna assumptions

Note: At frequencies below 1000MHz the antenna gain shall be assumed to be 0dBi for all classes. At frequencies above 3.25GHz the antenna gain shall be assumed to be -5dBi for all classes.

19: BRM Performance

19.1: BGAN Received Interference Rejection

When integrated into a BGAN terminal the BRM has the following BGAN interference rejection performance.

Interferer	Interferer bandwidth [MHz]	Min offset - channel centre to centre [MHz]	Power flux density [dBW/m^2]	Power [dBm]
Thuraya	0.16	0.2	-109	
Ligado (space component)	0.2	0.2	-100	
Ligado (space component)	0.2	0.4	-100	
ATC (LTE signal)	5	3.6	-	-45
	10	6.1	-	-45
LTE band 21 (occupying channel 1512 to 1517 MHz, per ETSI requirements)	5	5.6 - required channel at 1520.1 MHz	-	-31
		9.6 - required channel at 1524.1 MHz (protection SAW switched in)		-22

Table 43. Interference Rejection

Notes:
The **Power Flux Density** values assume use of an antenna with +18.7dBi gain.

The **Power** values are those at the FEM antenna interface, assuming +17dB of FEM gain, where the FEM is non-ATC/LTE compliant and the BRM is in ATC gain mode. With an ATC/LTE-compliant FEM, superior performance is obtained. Refer to the *ATC and LTE Compliant Front End Design* for more details.

19.2: GNSS Performance

The BRM has the following GNSS performance.

Parameter	Specification	Value	Unit	Notes
Time to first fix	Cold start, no BGAN operation	40	s	
Sensitivity	Cold start, no BGAN operation	137	dBm	
	Tracking and navigation, no BGAN operation	145	dBm	
	Tracking and navigation, with BGAN transmit and receive	T <- 130	dBm	

Table 44. GNSS performance

19.3: Power Consumption

The table below summarizes some key power consumption values for various modes of the BRM with 5.5V supplies at 25°C.

Mode	Parameters	Typ	Max	Units	Notes
Low power	GNSS off, 10 base-T Ethernet	178		mW	Minimal Ethernet activity, no BRM activity.
Network Idle, BRM in Sleep mode	GNSS on	556	700	mW	Minimal Ethernet activity
Continuous full duplex	GNSS on	4000	5000	mW	

Table 45. Power consumption specifications

20: BRM Key Blocks

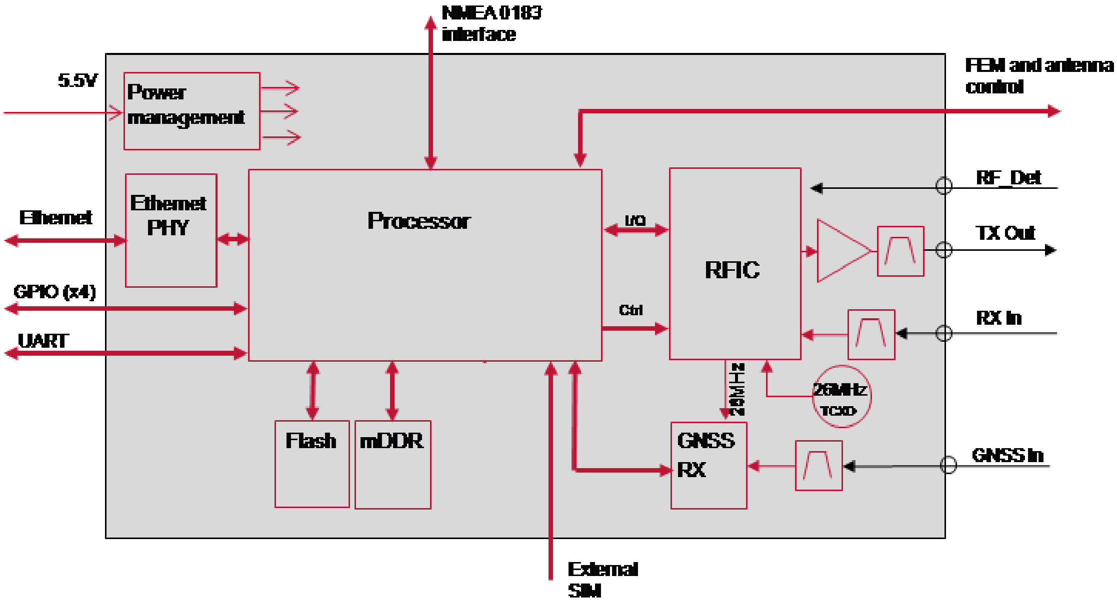

Figure 36. BRM block diagram

The digital subsystem undertakes all the physical layer, BGAN protocol stack command, data interfaces and web UI processing required for use in a wide range of terminals.

The BRM must be configured for use with an external SIM.

The RF subsystem is based around a custom RFIC. On board filtering of both transmit and receive reduces the RF filtering requirements in the FEM. The RFIC incorporates a transmit power detector eliminating the need for power control loops in the HPA. The receiver includes a broadband power detector and gain control to allow the large signal handling of the receiver to be improved with a small compromise in system Noise Figure as blockers occur.

High rejection custom SAW filters are used to reject LTE band 21 transmissions up to 1517 MHz. If the BRM receiver is tuned between 1524 - 1559 MHz then the input filtering is internally switched to provide additional protection Further interference rejection can be obtained by using a higher performance ATC/LTE FEM; refer to *ATC and LTE Compliant Front End Design* for details.

The location subsystem includes a dual channel GNSS receiver supporting multiple satellite constellations including GPS and Glonass. RF filtering is provided to protect both GPS (at 1575.42MHz) and Glonass (1598.6 to 1605.4MHz) from BGAN transmissions. Optionally, position and velocity information can be provided as NMEA strings from an external source.

21: BGAN Radio Module SDK

The BGAN SDK includes:

> Example Web UI (stored as a ZIP file on the BRM)

> Example configuration settings for a minimalistic modem terminal.

> Example FEM and antenna calibration files

> Example FEM software source code

> YAML file defining the RESTful command interface

22: Glossary

Term	Abbreviation	Definition
3rd Generation	3G	
Access Point Name	APN	The name of a gateway between a GPRS, 3G or 4G mobile network and another computer network, frequently the public Internet. A mobile device making a data connection must be configured with an APN to present to the carrier.
American Standard Code for Information Interchange	ASCII	A character-encoding scheme originally based on the English alphabet that encodes 128 specified characters - the numbers 0-9, the letters a-z and A-Z, some basic punctuation symbols, some control codes that originated with Teletype machines, and a blank space - into 7-bit binary integers. ASCII codes represent text in computers, communications equipment, and other devices that use text. Most modern character encoding schemes are based on ASCII, though they support many additional characters.
Auxiliary Terrestrial Component	ATC	
Broadband Global Area Network	BGAN	Inmarsat's BGAN service provides simultaneous voice and broadband data communications globally from small and lightweight satcom terminals. The service is provided by Inmarsat's global constellation of I-4 satellites.

Built-In Self Test	BIST	
BGAN Physical Layer Tester	BPLT	
BGAN Radio Module	BRM	
BPLT/UT Interface	BUI	Also known as the RF Test Interface
Challenge Handshake Authentication Protocol	CHAP	
Carrier-to-Noise Density Ratio	C/No	
Direct Current	DC	
Dynamic Host Configuration Protocol	DHCP	A standardised networking protocol used on Internet Protocol (IP) networks for dynamically distributing network configuration parameters, such as IP addresses for interfaces and services.
Distribution Partner	DP	
Digital Signal Processing	DSP	
Electromagnetic Compatibility	EMC	
ElectroStatic	ESD	

European Telecommunications Standards Institute	ETSI	
Front End Module	FEM	
Global Navigation Satellite System	GloNaSS	
Global Navigation Satellite System	GNSS	
General Purpose Input Output	GPIO	
General Packet Radio Service	GPRS	A packet oriented mobile data service on the 2G and 3G cellular communication system's global system for mobile communications.
Global Positioning System	GPS	A space-based satellite navigation system that provides location and time information in all weather conditions, anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites.
High Data Rate	HDR	
High Power Amplifier	HPA	
Hypertext Transfer	HTTP	An application protocol for distributed, collaborative, hypermedia information

Protocol		systems. HTTP is the foundation of data communication for the World Wide Web. Hypertext is structured text that uses logical links (hyperlinks) between nodes containing text.
Secure HyperText Transfer Protocol	HTTPS	
International Mobile Equipment Identity	IMEI	A unique identifier for a mobile device. IMEI is a form of ESN (Electronic Serial Number). IMEI numbers are typically 15 digits long.
Internet Protocol	IP	The method or protocol by which data is sent from one computer to another on the Internet.
JavaScript Object Notation	JSON	
Joint Test Action Group	JTAG	
Local Area Network	LAN	A network that connects computers and other devices in a relatively small area, typically a single building or a group of buildings. Most LANs connect workstations and personal computers and enable users to access data and devices, e.g., printers and modems, anywhere on the network.
Low Data Rate	LDR	
Light Emitting Diode	LED	

Low Noise Amplifier	LNA	
Long Term Evolution	LTE	
Look Up Table	LUT	
NOT AND	NAND	
Network Address Translation	NAT	A methodology of modifying network address information in Internet Protocol (IP) datagram packet headers while they are in transit across a traffic routing device for the purpose of re-mapping one IP address space into another.
National Marine Electronics Association	NMEA	
NOT OR	NOR	
Open Multimedia Application Platform	OMAP	
PPPoE Active Discovery Initiation	PADI	
Printed Circuit Board	PCB	
Packet Data Protocol	PDP	A Packet Data Protocol context transfers information about your data connections between the BGAN terminal and the BGAN network. The PDP context defines

		connection aspects such as routing, QoS and security. The BGAN terminal opens a primary PDP context or a secondary PDP context, depending on the IP data connection type. Refer to BGAN and PDP contexts for details.
Point-to-Point Protocol over Ethernet	PPPoE	A network protocol for encapsulating Point-to-Point Profile (PPP) frames inside Ethernet frames.
Quality of Service	QoS	The overall performance of a telephony or computer network, particularly the performance seen by the users of the network.
Radio Access Network	RAN	Part of a mobile telecommunication system. It implements a radio access technology. Conceptually, it resides between a device such as a mobile phone, a computer, or any remotely controlled machine and provides connection with its core network (CN). Depending on the standard, mobile phones and other wireless connected devices are varyingly known as user equipment (UE), terminal equipment, mobile station (MS), etc. RAN functionality is typically provided by a silicon chip residing in both the core network as well as the user equipment.
Representational State Transfer	REST	A software architecture style for building scalable web services. REST gives a coordinated set of constraints to the design of components in a distributed hypermedia system that can lead to a higher performing and more maintainable architecture. RESTful systems typically, but not always, communicate over the Hypertext Transfer Protocol (HTTP) with

		the same HTTP verbs (GET, POST, PUT, DELETE, etc.) which web browsers use to retrieve web pages and to send data to remote servers. The World Wide Web itself represents the largest implementation of a system conforming to the REST architectural style.
Radio Frequency	RF	
Radio Frequency Integrated Circuit	RFIC	
Read Only	RO	
Rich Text Format	RTF	
Read Write	RW	
Receive	Rx	
Surface Acoustic Wave	SAW	
SDU Configuration Module	SCM	
Software Development Kit	SDK	A set of software development tools that allows CAPs and VARs to create applications for use within the ISEP platform.

Simple Message Service	SMS	A text messaging service component of phone, Web, or mobile communication systems. It uses standardized communications protocols to allow fixed line or mobile phone devices to exchange short text messages.
Type Approval Code	TAC	
Transmission Control Protocol / Internet Protocol	TCP/IP	
Transmit	Tx	
Universal Asynchronous Receive Transmit	UART	
User Datagram Protocol	UDP	A communications protocol that offers a limited amount of service when messages are exchanged between computers in a network that uses the Internet Protocol (IP). UDP is an OSI Layer-3 protocol.
User Interface	UI	
Uniform Resource Locator	URL	
Universal Subscriber Module	USIM	

User Terminal	UT	Refers to a GX or L-band Terminal, which is essentially the satellite receiver for relevant Ka or L-band services at a Remote Site.